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THIRTIETH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

The thirtieth meeting of the Society was held at the Mount Wilson Observatory, Pasadena, California, on September 17 to 20, 1923. The meeting was in affiliation with the Pacific Division of the American Association for the Advancement of Science, which met in Los Angeles at the same time, and all sessions were also held jointly with the Astronomical Society of the Pacific. The eclipse of September 10 had attracted a large number of professional and amateur astronomers, both from the United States and abroad, and there were present at the meetings astronomers from Canada, Mexico, Argentina, Australia, Japan, England, France, Spain, Belgium, and Holland. The meeting was the largest in the history of the Society, nearly one hundred members being present, and the attendance at the sessions averaged about one hundred and twenty-five.

As contrary to all expectations there had been a general prevalence of cloudy weather on the Pacific Coast at the time of the eclipse, the days preceding the meeting were marked by the gathering in Pasadena of the personnel of the various disappointed parties, and the native Californians for once were not boasting of their climate. The visitors made use of the opportunity to visit the places of interest about Los Angeles, when it was not raining, and to commiserate with each other, but after all the shadow of the eclipse hung very lightly over the meeting, and from outward appearances it was largely a joke to travel thousands of miles and to work weeks or months only to be disappointed at the end.

The program began on the afternoon of Sunday, the 16th, with a splendid gathering and tea at the home of Dr. and Mrs. Walter S. Adams in Pasadena. The next morning it was raining, as might have been expected, and most of the members, who were quartered in Pasadena, made the trip of an hour or so to the University of Southern California, in Los Angeles, where the first session for technical papers was held. This was followed by a general research conference of the Association during the noon hour, and in the afternoon there was a

symposium on eclipses and relativity which attracted a large audience. There were four addresses, as follows:

W. W. Campbell—Some Conditions Apparently Existing in the Solar Corona.
S. A. Mitchell—How the Spectrum of the Sun's Atmosphere is Studied at Eclipses and the Interpretation of the Results through the Aid of Modern Physics.
Charles E. St. John—The Constitution of the Sun's Atmosphere, the Levels of the Gases and the Nature of their Circulation. Results bearing on the displacements of solar spectrum lines as required by the theory of relativity.
R. J. Trumpler—Relativity as Represented by the Einstein Eclipse Problem.

Although most of the visiting astronomers had experienced a cloudy sky at the time of the eclipse on September 10, partial or complete success was reported by observers in the vicinity of Santa Barbara, California, and in the interior of Mexico, and preliminary reports, with photographs of the corona, were given by Messrs. Brackett, Worthington, Douglass, Gallo, and Miller.

On Monday evening, the members of the Society and of the Association re-assembled in the Bovard Auditorium, University of Southern California, to listen to the address of the retiring president of the Pacific Division, Dr. E. Percival Lewis, who spoke on "The Contributions of Astronomy to Civilization."

On Tuesday morning, the Society met at the Pasadena headquarters of the Mount Wilson Observatory, where the session for papers was held in the library. Opportunity was given both before and after the session for inspection of the offices, laboratory, and shops of this unique astronomical institution. In addition to the regular list of papers, members were privileged to hear from two Americans who had come far to be present at the meeting, Messrs. C. D. Perrine of the Cordoba Observatory and B. H. Dawson of the La Plata Observatory, who gave accounts of the work these institutions are doing in the southern hemisphere.

The members were guests of the Mount Wilson Observatory for luncheon, which was served in the Government Building. In the afternoon the Society met at the new Norman Bridge Physical Laboratory of the California Institute of Technology in a session of papers of joint interest with the physicists. After this session, there was opportunity to inspect the facilities of the laboratory.

One event, which was of especial interest to about thirty members, was the reunion dinner of present and former students and members of the staffs of the Lick Observatory and Students' Observatory, University of California. This was held at the University Club, Pasadena, on Tuesday evening, and represented all generations of astronomers who had been at these institutions, beginning with Mr. Ambrose Swasey, one of the creators of the Lick telescope. To the great regret of all, both President Campbell and Professor Leuschner had been

called home by the disastrous conflagration in Berkeley, but it was a relief to learn that the homes of neither of them had been harmed.

The public address of the Association on Tuesday evening, was by Dr. John C. Merriam, president of the Carnegie Institution of Washington, on "The Meaning of History as Illustrated by the Records Secured at Rancho La Brea."

On Wednesday morning, members of the Society and friends gathered early at the Pasadena office for conveyances up Mount Wilson. After the thrilling ride on the steep, winding road, the members had all arrived safely at the summit before noon and were distributed among the cottages of the Mount Wilson Hotel. After a preliminary visit to some of the instrumental wonders on the mountain, luncheon was served at the Monastery which, for this special occasion, was forced to belie its name. As a real California sun was shining by this time, an awning had been erected in the courtyard. After lunch, the members visited the Smithsonian station close by, and were particularly interested in Dr. Abbot's solar cooker.

In the afternoon, the final session was held under unique circumstances, in the dome of the one hundred-inch Hooker telescope. With the great reflector turned low in declination, there was ample room for the audience of more than one hundred on the platform underneath the mounting, and the movable dome and shutters gave unusual facilities for proper gradation of light and dark, depending upon the needs of the program. The papers included reports on current work with the one hundred-inch reflector, and ended with a communication from Dr. George E. Hale on "The Development of Industrial Research," a paper which is printed in full on later pages of this report. It was to the regret of all that the originator of the great institution on Mount Wilson could not be present, but thanks to the facilities of the telegraph the Society was able to send a message of greeting to its absent host and to receive a word from Dr. Hale in reply.

The all too short remaining time of that day was open for strolls about the mountain, and tea at the Kapteyn Cottage, served by the lady members of the staff. Dinner was at the Mount Wilson Hotel. In the evening, with both the large reflectors available, the members had the opportunity to renew or increase their enthusiasm for the scenery of the heavens. The region of Copernicus on the moon seen with the sixty-inch, and the Hercules cluster with the one hundred-inch, were enough to bring forth exclamations of surprise from those long familiar with views with smaller instruments. These and other objects kept the visitors oscillating from one great dome to the other until a late hour. To some, however, perhaps the best display of all was the spectacle of the lights of Pasadena, Los Angeles, and other cities in the valley below.

Some of the members risked their lives and took the return stages for Pasadena that night, but many remained over and made the trip

the next morning. By Thursday noon, the meeting was well dispersed, and the long-anticipated combination of the total eclipse and the meeting of the Society of 1923 had become a memory.

This being the annual meeting, there were various matters of business which were acted on by the Council and at the general sessions. Announcement was made of the election of the following as honorary members:

Herbert Hall Turner, Director of the University Observatory, Oxford.

Benjamin Baillaud, Director of the Paris Observatory.

As a result of the election held at the last session, those in the following list whose terms begin in 1923 were elected as officers, the others continue to serve unexpired terms:

President	W. W. Campbell	1922-1925
Vice-Presidents	Henry Norris Russell	1922-1924
	Ernest W. Brown	1923-1925
Secretary	Joel Stebbins	1923-1924
Treasurer	Benjamin Boss	1923-1924
Councilors	A. O. Leuschner	1921-1924
	Frederick Slocum	1921-1924
	John M. Poor	1922-1925
	Chas. E. St. John	1922-1925
	Heber D. Curtis	1923-1926
	Anne S. Young	1923-1926
Ex-President	Frank Schlesinger	

Members of the Division of Physical Sciences, National Research Council:

W. W. Campbell	1921-1924
Edwin B. Frost	1922-1925
Ernest W. Brown	1923-1926
Harlow Shapley	1924-1927

The following persons were elected to membership, making a total of four hundred and one in the Society:

E. F. Adams, Mount Wilson Observatory, Pasadena, Calif.

Paul Biefeld, Denison University, Granville, Ohio.

J. W. Campbell, University of Alberta, Edmonton, Alberta, Canada.

W. H. Christie, Dominion Astrophysical Observatory, Victoria, B. C., Canada.

W. W. Coblentz, Bureau of Standards, Washington, D. C.

Leslie J. Comrie, Swarthmore College, Swarthmore, Pa.

C. H. Davis, Yale University Observatory, New Haven, Conn.

Mary S. Fretz, Mount Wilson Observatory, Pasadena, Calif.

Mary Howe, Vassar College Observatory, Poughkeepsie, N. Y.

T. S. Jacobsen, Lick Observatory, Mount Hamilton, Calif.

F. C. Leonard, Southern Branch, University of California, Los Angeles, Calif.

Ross W. Marriott, Swarthmore College, Swarthmore, Pa.

Hiram M. Perkins, Ohio Wesleyan University, Delaware, Ohio.

Phoebe Poole, Mount Wilson Observatory, Pasadena, Calif.

Dorothea Isaac-Roberts, 38 Hill Point Ave., San Francisco, Calif.
A. C. Schock, Central High School, Broad and Green Sts., Philadelphia, Pa.
Dorothy L. Schwan, Box 224, Route 1, Mountain View, Calif.

The following members of the Society were present at the Mount Wilson meeting:

C. G. Abbot
E. F. Adams
W. S. Adams
Mrs. W. S. Adams
R. G. Aitken
D. Alter
J. A. Anderson
H. D. Babcock
C. E. Barnes
Harriet W. Bigelow
F. P. Brackett
Ada M. Brayton
Cora G. Burwell
Mary R. Calvert
J. W. Campbell
W. W. Campbell
Annie J. Cannon
W. A. Cogshall
R. T. Crawford
H. D. Curtis
B. H. Dawson
A. E. Douglass
F. Ellerman
C. T. Elvey
Alice H. Farnsworth
E. A. Fath
P. Fox
Mary S. Fretz
E. B. Frost
J. Gallo
W. M. Hamilton
Margaret Harwood
W. P. Hoge
L. G. Hoxton
E. P. Hubble
M. L. Humason
H. M. Jeffers
W. R. Jewell
A. H. Joy
Mary C. Joyner
Lois M. Keener
A. S. King
C. O. Lampland
Eleanor A. Lamson
Isabella Lange
E. L. Larkin
O. J. Lee
F. C. Leonard
A. O. Leuschner
Mrs. Percival Lowell
W. J. Luyten
W. D. MacMillan
Mrs. H. M. Marsh
Beatrice W. Mayberry
D. H. Menzel
P. W. Merrill
D. C. Miller
J. A. Miller
S. A. Mitchell
D. W. Morehouse
F. R. Moulton
S. B. Nicholson
J. A. Parkhurst
F. G. Pease
C. D. Perrine
E. Pettit
Mrs. E. Pettit
J. S. Plaskett
Phoebe Poole
Myrtle L. Richmond
L. Rodés
A. J. Roy
F. H. Safford
C. E. St. John
R. F. Sanford
F. H. Seares
E. C. Slipher
J. Stebbins
H. T. Stetson
G. Stromberg
R. Sullivan
A. Swasey
G. D. Swezey
S. D. Townley
R. Trumpler
R. H. Tucker
F. D. Urie
A. van Maanen
Marion E. Vosburgh
Louise W. Ware
H. C. Wilson
I. Yamamoto
Jessica M. Young

It was announced that the next meetings of the Society had been fixed by the Council as follows: 1923 December, at Vassar College; 1924 September, at Dartmouth College; and 1924 December, at Washington, D. C.

THE POSSIBILITIES OF INSTRUMENTAL DEVELOPMENT.

By George E. Hale.

Nothing is more encouraging to the scientific investigator than the rapid multiplication in recent years of the possibilities of instrumental development. In astronomy the opportunities for advance have been vastly enlarged by the remarkable progress of physics and chemistry and the many new instruments and methods thus rendered available. To appreciate our advantages, we have only to glance rapidly over the history of science and contrast present possibilities with those of the past.

The beginning of the new year, practically coinciding with the annual inundation of the Nile, was fixed by observations of the heliacal rising of Sirius before 4000 B. C. Throughout their entire history the Egyptian priests were astronomers, yet their sun-dials, water clocks, and the crude "Merchet", a measuring instrument for determining the time from observations of stars near the meridian, apparently underwent no important improvement down to the Greek occupation of Egypt. The Babylonians, although much more effective observers than the Egyptians, have left us no instruments, unless the "astrolabe" found in the palace of Assurbanipal may be thus classed. The Greeks invented several instruments, which are described by Ptolemy in the Almagest. Most of these consist essentially of a graduated arc of a circle, provided with adjustable sights and supported in the plane of observation. So completely did these instruments embody the ingenuity of the Greeks that they were adopted without important change by the Arabs, Hindus, and Chinese, and served for the equipment of Tycho Brahe's great observatory in the period of revival of the sixteenth century. Tycho devoted special attention to the improvement of instruments, which he constructed in his own shops. But though spectacles had been worn since the end of the thirteenth century, he little suspected the great opportunity they placed within his grasp.

The history of lenses is full of interest. It is very improbable that the disk of rock crystal, oval in shape and ground to a plano-convex form, which was found by Layard in Sargon's Palace at Nimrond, was actually intended for use as a lens, in spite of Sir David Brewster's contrary opinion. Nor can it be safely affirmed from their minuteness of detail and perfection of execution that the finely engraved gems of antiquity were cut under lenses. Pliny the elder and others state that globes filled with water were used as burning glasses, and Seneca remarks that "letters though small and indistinct are seen enlarged and more distinct through a globe of glass filled with water." Yet while defects of vision were frequently discussed by many classic authors, they made no reference to the simplest optical aids and myopia was repeatedly declared to be incurable down to the end of the thirteenth century, when spectacles first came into use.

Roger Bacon and his teacher Grossteste undoubtedly understood some of the properties of lenses and concave mirrors, but the evidence advanced to support the opinion that Bacon used telescopes for astronomical observations is not convincing. The early history of the telescope remains rather obscure, but from our point of view the most important fact is its application in astronomy by Galileo and the revolution in human thought effected by his discoveries. His sudden recognition and utilization of a principle which had certainly been applied in the case of spectacles for three hundred years quickly transformed the equipment of the observatory and laid the foundation of astrophysical research. In 1630 Francesco Generini saw the feasibility of using the telescope for increased precision in pointing, presumably by introducing threads into the focal plane of the eye-piece. About ten years later the inventor of the micrometer undoubtedly used this method. The modern period of astronomical measurement was thus begun.

As for the telescope itself, it was first improved by the invention of the Keplerian eye-piece and then increased in focal length to overcome the troublesome effects of aberration. Rayleigh has shown that a single lens of 1.7 inch aperture is as good as an achromatic when its focus is 66 feet. Huygens, who worked out the theory of aberration, consequently greatly increased the aperture and focal length of his telescopes. He also devised the Huygenian eye-piece and was rewarded for his efforts by the discovery of the true nature of the rings of Saturn. Three of his objectives, with focal lengths of 122, 170, and 210 feet respectively, are still in the possession of the Royal Society. Telescopes up to 600 feet in length were made in this period, but the difficulty of finding and following the celestial object seriously affected their value. Obviously they could not be carried on equatorial mountings, first described for telescopic purposes in Scheiner's Rosa Ursina, but really not different in principle from the equatorial armilla of Tycho Brahe. An accessory of the highest importance developed at this time was the pendulum clock, devised by Huygens following Galileo's discovery of isochronism.

Two steps taken for the purpose of overcoming chromatic aberration ultimately proved successful. The reflecting telescope, introduced by Gregory and Newton, reached apertures of 4 feet in the hands of Herschel, and 6 feet in those of Lord Rosse. The invention of the achromatic objective, followed by the production of optical glass in larger and larger disks, made way for the great refractors of the present day. Their high perfection, like that of the modern reflector, is the result of successive advances in the art of the glass maker, the metallurgist, the mechanical engineer, and the optician, and the development of modern machine tools, which Lord Rosse did not possess. Even if the photographic plate had then been perfected, the absence of an accurately driven equatorial mounting would have rendered it use-

less with his 6-foot reflector. The refinement and precision of the modern meridian circle, with its nearly perfect pivots and beautifully graduated circles, is another result of the improved art of the instrument maker, which is also illustrated in such valuable accessories as the latest types of clocks, the recording chronograph, and the moving wire micrometer.

The first telescopes collected about 80 times as much light as the unaided eye, and this light-gathering power has now been increased to about 200,000 times that of the eye. As the quality of the atmosphere and the optical and mechanical perfection of the best modern instruments are sufficiently good to permit all of this light (barring losses by reflection) to be concentrated and held in a very small image, the gain thus effected is enormous. But the advantages derived from the introduction and improvement of the photographic plate, and the development of many auxiliary instruments and methods, are still more important.

When Newton decomposed sunlight with a prism in 1672, he took the first great step in the initiation of spectroscopy. It was not until 1803, however, that Wollaston, using a narrow slit instead of Newton's wider one, detected the principal dark lines in the solar spectrum, nearly six hundred of which were measured by Fraunhofer in 1814. Their interpretation by Stokes, who in 1852 recognized that the double D line is due to sodium vapor, which absorbs the same radiations that it emits, and later by Kirchhoff and Bunsen, who in 1859 identified many terrestrial elements in the sun, provided the means of determining the chemical composition of celestial objects.

The study of stellar evolution, foreshadowed by Herschel and by Laplace in the nebular hypothesis, was thus rendered possible in the very year of the publication of Darwin's "Origin of Species." This was a tremendous advance, even when only the classification of stellar spectra, at once undertaken by Secchi and Huggins, and the apparent variation of chemical composition with stellar evolutional progress, are considered. But the chief significance of the adoption of the spectroscope in the observatory lies in the extraordinary versatility of this instrument, and the possibilities it affords of utilizing in astronomy the widest variety of physical and chemical discoveries.

In 1842 Doppler tried to prove that the color of a star depends upon its velocity. If a star radiated monochromatic light and its velocity were great enough, his conclusion would be correct. Rightly applied with the spectroscope, his principle has given us the means of measuring the motions of gases in the solar atmosphere; the rotation of the sun, planets, and nebulae; the orbital velocity of close double stars discoverable only by this method; and the velocity in the line of sight of various celestial objects.

I wish that time permitted me to dwell on the extraordinary harvest which has resulted from the skilful application of this and other prin-

ciples of physics, but I can only recall a few of them. The shift toward red or violet of spectral lines by pressure affords a means of measuring the pressure in stellar atmospheres, after other effects have been allowed for. The variation of the relative intensities of lines with temperature gives one clue to stellar temperatures, and has also led indirectly to Adams' beautiful method of deriving absolute magnitudes and parallaxes from stellar spectra. Reduced to a sound scientific basis through the recent advances of physics, the study of line intensities has also become one of our most powerful guides, not only to the nature of stars, but to the structure of the atom itself. The shift of the maximum of intensity in the spectrum as a function of the temperature, the influence of magnetic and electric fields on radiation, the phenomena of polarization, of anomalous dispersion, and of optical resonance are also among the numerous discoveries of the physicist which the astronomer has already utilized, with important positive or negative results.

In addition to the spectroscope, the astronomer has derived from the physical laboratory a long line of other valuable instruments. The photometer, now powerfully supplemented and largely displaced by photographic methods, has given us the magnitudes of tens of thousands of stars. The thermopile and the bolometer have led to remarkable advances in our knowledge of the infra-red spectrum, precise measures of the varying intensity of the solar radiation, the determination of the heat radiation of stars as faint as the thirteenth magnitude, and even to studies of the energy spectra of some of the brighter stars. The photo-electric cell has yielded stellar photometric measures of surprising precision. The radiometer, which gave the first actual measure of the pressure of radiation, now known to play such a dominant part in the massive stars, has recently provided the means of detecting the last wave-lengths missing in the long range from the gamma rays of radium to radio waves 20,000 meters in length. The interferometer, springing from Young's famous interference experiment of more than a century ago, has served for scores of brilliant successes, recently culminating in the determination of the angular diameters of giant stars.

Without attempting to enumerate more of the astronomer's long list of debts to the physicist and chemist, let us look for a moment at the increase in the precision of measurement effected by instrumental advances. The star places of the Greek were given to the nearest 10′ of arc, one-third the diameter of the moon. Tycho succeeded in reducing the probable error of a single measure of the distance between two neighboring stars to 57″. In double star observations the probable errors of the best micrometric measures are about 0″.1. In modern photographic parallax determination the probable error is about 0″.005 to 0″.010. With the interferometer, the probable error of a single measure of the separation of the components of Capella is 0″.001. The diameter of Arcturus, 0″.019, can be similarly measured with a probable

error of about the same amount.

The advantages to be gained by the early utilization of the rapid progress of the physicist and chemist are obvious. Almost any discovery may help us directly or indirectly. We are interested in new organic dyes because they may improve the sensitiveness of our plates in various regions, especially in the infra-red, a most promising field for future research. We earnestly hope for a reduction in the size of the grain of the most rapid photographic plates, which would be equivalent to a marked increase in the aperture of our telescopes. We keenly watch for the appearance of new alloys, perhaps suitable for telescope mirrors or for the special needs of optical gratings; progress in the manufacture of optical glass; the production of large masses of clear fused quartz for prisms or mirrors—every technical advance, in fact, that we can learn to utilize. And we are equally anxious to benefit by the constant improvement of high tension transformers, electric furnaces, vacuum tubes, electromagnets, and the many other devices on which we depend for the imitation and interpretation of celestial phenomena.

These illustrations of the increasing possibilities of instrumental development have not been enumerated in strict chronological sequence, but a glance at this partial list will show how rapidly the opportunities of the astronomer have multiplied in recent years. Another point should be noted: the obvious change is not always the most important one, and the greatest advances may come from the recognition of possibilities that are not immediately apparent. Hence the astronomer cannot watch too intently the progress of related sciences, and especially the numerous devices and methods which are constantly arising in various fields. Such beautiful new instruments as the X-ray spectrograph or the mass spectrograph of Aston, while perhaps not directly applicable in astronomy, may contain hints, and also yield results, which can be used to advantage.

Such considerations will help to explain the somewhat unorthodox equipment and policy of the Mount Wilson Observatory. We have tried from the outset, with the valuable co-operation of our Research Associates, to utilize some of the more obvious possibilities offered by the progress of physics and chemistry, and to gain such advantages as laboratory conditions and methods place at our disposal. Hence the design of the Snow and tower telescopes, equipped for solar research; the coudé principle and constant temperature laboratories of the 60-inch and 100-inch reflectors, arranged for the photography of stellar spectra under high dispersion and for investigations like those with the thermopile and bolometer on stellar radiation and energy spectra; the exceptional care taken to secure smooth rotation of the 100-inch dome, in order to diminish the vibration of the high dispersion stellar spectrograph (soon to be mounted on its pier) during exposures continued for several nights; the construction of the ruling machine, one of the

prime purposes of which is to permit such experiments as have just rendered possible the concentration of most of the incident light in any desired order of spectrum; the development of the stellar interferometer, first in conjunction with the 100-inch telescope and now as a separate instrument. Hence the provision of machine and optical shops adequate for a wide range of constructional work and a physical laboratory in which to conduct researches required for the interpretation of celestial phenomena. Hence also our close co-operation with the California Institute of Technology, the recent growth of which as a research institution is so advantageous to the observatory.

Looking ahead, and speculating on the possibilities of future instruments, it may be mentioned that comparative tests of the 60-inch and 100-inch telescopes promise well for larger apertures. Their practicability, so far as this depends upon atmospheric limitations, can be fairly well tested by observations of the united star images given by the two mirrors of a stellar interferometer at increasing separations. The production of large mirror disks is another problem. Fused quartz mirrors, if they can be made of sufficient dimensions, will be extremely valuable for solar telescopes and large reflectors because of their low co-efficient of expansion, but for moderate apertures pyrex glass has already proved a fairly effective substitute. As for the stellar interferometer, I believe it will ultimately attain apertures of 100 feet or more, possibly in some fixed form, with accurately controlled coelostats. Fixed telescopes and spectrographs for solar work, whether horizontal or vertical, can be shortened if desirable by the use of telephoto lenses or by combinations of mirrors. Both the ultra-violet and the less refrangible part of solar and stellar spectra deserve more consideration than they have received, and here especially improvements in the photographic process, as well as in prisms and reflecting surfaces for the ultra-violet, are greatly to be desired. No increase in the resolving power of the grating is required for astronomical purposes, but more light, obtainable from greater area of ruled surface, with concentration in a single order, is still needed for various purposes.

I shall not attempt in this paper to deal with less obvious possibilities, or to discuss particular problems. Let me conclude with the reminder that if instruments are important, "the man at the eye-end" is more important by far. In the Hindu treatise Siddhanta Siromani, the astronomer Bhaskara, after describing a new form of instrument, exclaims: "But what does a man of genius want with instruments, about which numerous works have treated? Let him only take a staff in his hand and look at any object along it, casting his eye from its end to the top, there is nothing of which he will not then tell its altitude, dimensions, etc." If we cannot afford the sacrifice of precision which is here so lightly recommended, we may at least remember that the mathematician embodies in himself the most powerful of all instruments for the solution of celestial problems, and we may also find encouragement in

the simple means that have served in many classical researches. When Young laid the foundations of the wave theory of light, and discovered the principle of the interferometer, his instruments were limited to a small mirror, a few bits of paper and cardboard, some fine hairs, and a couple of knife blades. If we are not mathematicians or experimental physicists, and do not share in the use of large telescopes, we may still find ample encouragement in the history of astronomical progress. We have only to recall the splendid results obtained by systematic observation with small telescopes by such men as Burnham, Barnard, and Carrington, or those derived, also with small instruments, by men like Huggins, Secchi, and the pioneers in astronomical photography, from the prompt and intelligent application of methods and devices borrowed from the laboratory.

ABSTRACTS OF PAPERS

THREE STELLAR SPECTROSCOPIC NOTES.

By W. S. Adams and A. H. Joy.

A spectroscopic investigation of 34 stars in the open cluster of Praesepe leads to the following results: Twenty-six stars show radial velocities which indicate that they belong to the cluster, five are spectroscopic binaries and three stars do not belong. The radial velocity of the cluster is +33 km, and its spectroscopic parallax is +0″.007.

A study has been made of 27 stars of the cluster-type of variable. All these stars have periods of the order of 0.5 day. The dispersion in radial velocity is found to be extraordinarily great and the average velocity very high. Eight stars have velocities of over 100 km, and of these one has a velocity of —225 km, and another of —380 km. The range in velocity for the stars investigated is not great, about 50 km on the average.

A special study has been made of 215 giant K-type stars to learn whether the small dispersion in absolute magnitude is characteristic of such stars, or is due to the failure of the spectroscopic criteria to distinguish between small differences in absolute magnitude. The results show: first, that the spectroscopic criteria are adequate, and hence that the dispersion is actually small; second, that the mean absolute magnitudes for these stars as derived from parallactic motion, peculiar motion and trigonometric parallaxes, are in excellent agreement; third, that systematic corrections to the spectroscopic parallaxes published previously are small in amount.

HYPOTHETICAL PARALLAXES OF 154 A VISUAL BINARY STARS.

By R. G. Aitken and Margaret Powell.

The hypothetical parallaxes have been computed by Jackson and Furner's formulae for all A stars showing motion in the time covered by Aitken's measures, provided measures made at three or more epochs were available. There are 154 such pairs, for four of which orbits have been computed. In these four cases the orbit elements have been utilized. The mass of every system was, in the first instance, assumed to be $1.6\odot$; afterwards the computation was repeated taking for each system the value assigned as the mean for stars of its group in the recent paper by Russell, Adams, and Joy, "A Comparison of Spectroscopic and Dynamical Parallaxes." The tables give both sets of values. A definite numerical increase in the corresponding absolute magnitudes as we pass from spectral class A toward class M is noted in the dwarf stars, but not in the giant stars. The computed parallaxes are all small, as was to be expected, and since the stars were selected on the basis of rapid orbital motion, the average parallax of the close pairs of Aitken's list will be still smaller.

ON THE NUMBER AND DISTRIBUTION OF STARS WITH SPECTRA IN CLASS B CONTAINING EMISSON LINES.

By R. H. Curtiss.

The number of stars belonging to the group having spectra in Class B with hydrogen emission lines now reaches approximately two hundred. It seems probable that about two hundred and fifty of these stars with Hβ observably bright with slit spectrographs exist within the magnitude limits of the Henry Draper Catalog and perhaps a hundred more with only Hα bright.

These stars are well dispersed throughout the spectral divisions from B0 to B6 with a maximum of occurrence at B3-B4. They are well represented in B8 but very rarely outside of Class B.

The published lists of these stars taken together continue to show the existence of much greater proportions of emission line stars in Class B among the brighter magnitudes. A separate count of these stars having emission lines in the photographic region shows the same effect in no less degree. A discovery factor is certainly present here but with due allowance for that it seems probable that the brighter and perhaps larger stars tend more strongly to develop emission lines.

There is no great variation in the number of emission lines in these spectra for all magnitudes from division B0 to B6, though there is a possible maximum in the average number of such lines in any spectrum at B2e. Stars later than B6e have fewer emission lines on the average.

The galactic distribution of these emission line stars follows reasonably closely that of all Class B0-B5 objects. The average galactic distance diminishes in a striking manner, from about 14°.5 for the brighter stars to five or six degrees for the stars averaging about eighth magnitude. The median galactic latitude varies in a similarly progressive way from about —5° for the brighter stars to —1°.5 for the fainter magnitudes.

THE RADIAL MOTION OF Y SAGITTARII IN 1922 AND 1923.

By John C. Duncan.

Changes in the spectrographic orbit of this Cepheid variable star were communicated to the Society by the author in 1921. Further studies were carried on at Mount Wilson in 1922 and at the Lick Observatory in 1923, and the resulting velocity curves are exhibited by lantern slides. The greatest changes appear in the velocity of the system and the eccentricity. In the four years in which the star was studied spectrographically, these elements were:

	γ	e
1908	+3.6	0.21
1921	—5.9	0.42
1922	—9.5	0.46
1923	—0.7	0.40

The observations of 1923 were made with the dispersion of three prisms; those of the earlier years, principally with single prism dispersion.

THE ORBIT OF THE SPECTROSCOPIC BINARY BOSS 1452.

By W. E. Harper.

Twenty-five observations of this A-type star taken in the year 1918, 1919, 1922 and 1923 are used in the determination of its orbit. The hydrogen lines, magnesium 4481 and calcium K were the lines most frequently measured for radial velocity. A least-squares solution gave the following values of the elements.

$$\begin{aligned} P &= 2.9331 \text{ days} \\ e &= 0.030 \\ \omega &= 359°.25 \\ K &= 76.02 \text{ km} \\ \gamma &= -3.86 \text{ km} \\ T &= \text{J. D. } 2{,}423{,}440.103 \\ a \sin i &= 3{,}064{,}800 \text{ km} \end{aligned}$$

THE ORBITS OF THE SPECTROSCOPIC COMPONENTS OF BOSS 6148.

By W. E. Harper.

Thirty spectrograms of this F-type star, secured with the single-prism spectrograph attached to the 72-inch reflector, were used in the determination of its orbit. Of this number 23 showed the spectra of both components, which are quite similar. A combined least-squares solution, after preliminary elements had been obtained graphically, gave the following results.

$$
\begin{aligned}
P &= 12.155 \text{ days} \\
e &= 0.278 \pm 0.007 \\
\omega_1 &= 33°45 \pm 1°24 \\
\omega_2 &= 213°45 \pm 1°24 \\
K_1 &= 71.52 \text{ km} \pm 0.56 \text{ km} \\
K_2 &= 72.97 \text{ km} \pm 0.54 \text{ km} \\
\gamma &= +11.98 \text{ km} \pm 0.32 \text{ km} \\
T &= \text{J. D. } 2{,}422{,}162.601 \pm 0.034 \text{ day} \\
a_1 \sin^3 i &= 11{,}482{,}800 \text{ km} \\
a_2 \sin^3 i &= 11{,}715{,}500 \text{ km} \\
m_1 \sin^3 i &= 1.704 \odot \\
m_2 \sin^3 i &= 1.671 \odot
\end{aligned}
$$

METHODS AND RESULTS OF THE ABSOLUTE MAGNITUDE DETERMINATION OF STARS AT THE DOMINION ASTROPHYSICAL OBSERVATORY.

By W. E. Harper and R. K. Young.

On the completion of the Boss program of radial velocity the authors undertook to utilize the spectra so obtained for the determination of the absolute magnitudes of the stars concerned. It was necessary to secure additional spectra of stars of known parallax which would serve as standards to correlate line intensity and absolute brightness. Spectra of 500 such stars have been obtained and these with the Boss stars and others since observed from the Harvard Revised Photometry, Volume 50, bring the available number of stars to over 1000.

For all the stars the type was redetermined by comparison with a number of spectra accepted as standard. These standard stars were

15 Vulpeculae	A5	β Andromedae	M0
γ Herculis	F2	α Orionis	M1
γ Serpentis	F7	η Andromedae	M2
ζ Herculis	G1	β Pegasi	M3
β Bootis	G5	Pi X 203	M4
α Bootis	K0	α Herculis	M6
π Herculis	K3	R Lyrae	M7
γ Draconis	K5	45 Arietis	M8
δ Ophiuchi	K9		

This scale agrees very closely with both Adams' scale and the Harvard scale. It is rather a fortunate coincidence that the scale in the

M-types which we adopted independently in 1921 should agree almost exactly with that recommended by the committee on the classification of stellar spectra to the International Astronomical Union at the Rome meeting in 1922.

The measuring of line intensities in the spectra as a criterion of the absolute magnitude has been the subject of considerable investigation. We have adopted Adams' scheme of measuring the ratio of a pair of lines. Artificial spectra were made by Dr. Young which showed a series of spectral lines as nearly similar to stellar lines as possible and graded in intensity. Each observer used a scale of this kind. The artificial standard was superimposed close to the lines to be measured and the estimations were made by noting how many steps on the standard scale gave the same impressions of intensity difference as the pair of lines in the spectrum. The use of a scale of this kind holds the quantity which Adams speaks of as a "step" constant so that one can go back to the stars after a long absence from the work and repeat the measures satisfactorily. Furthermore other observers, given the same comparison scale, would be able to use our curves for relating absolute magnitude to line intensity, provided the spectra were obtained with similar dispersion.

We have not found it necessary to use separate reduction curves for the Cepheid variables. These seem to form a class which join onto the giants, the c-characteristic being one of degree. The c-characteristic has often been understood to be associated with the sharpness of the line; this is a misunderstanding as it is more associated with the intensity of the absorption.

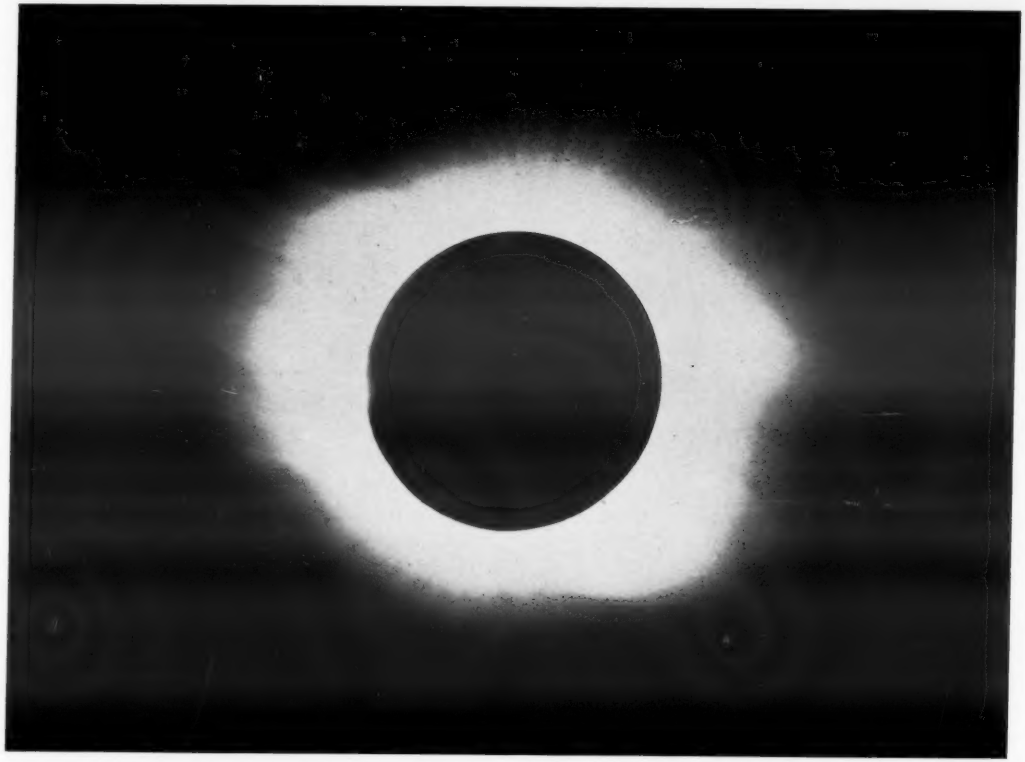
The lines used by the Mount Wilson observers were examined and used in the types where they were found suitable. We found that certain lines in individual stars sometimes showed large departures from the normal values. Consequently if the final means are to give a good value for the absolute magnitude many lines must be available. A search for new lines resulted in several pairs being found suitable, and certain of the pairs have been found useful in the giants. Thirteen sets of lines have been used, though not all in any one type. These include the ones discovered at Mt. Wilson and are as follows.

$$\frac{4071}{4077},\ \frac{4162}{4168},\ \frac{4202}{4207},\ \frac{4215}{4250},\ \frac{4247}{4250},\ \frac{4258}{4260},\ \frac{4272}{4290},\ \frac{4455}{4462},\ \frac{4455}{4494},$$

$$\frac{4455}{4482},\ \frac{4455}{4489},\ \frac{4489}{4494},\ \frac{4494}{4495}.$$

The scale of parallaxes we have used in graduating the curves has been as follows. For those stars whose parallax is fairly large and well determined we have used the trignometrical parallax as given by Adams *et al* in his list of 1648 stars, or if new determinations had been

PLATE XXXII.



PHOTOGRAPH OF THE SOLAR CORONA, SEPTEMBER 10, 1923.

Taken by the Sproul Observatory Eclipse Expedition at Yerbanis, Mexico. The inner details of the corona have been lost in the processes of reproduction, partly in the photographic print and partly in the engraving.

PLATE XXXIII.

THE RIM OF THE SUN.

Photographed with the 65-foot camera of the Sproul Observatory Eclipse Expedition at Yerbanís, Mexico, September 10, 1923. There is a remarkable disturbance shown in the top of the picture, showing some hooded prominences.

POPULAR ASTRONOMY, No. 309.

made since this list was published these were incorporated using the same system of weights as outlined in the same paper. For stars whose parallax was small or poorly determined we have used proper motion methods. The general scale seems to be in fair agreement with that given in Adams, Joy and Stromberg's paper on the parallax of 1646 stars. In order, however, that the systematic errors may be properly investigated we are publishing the results for each line and each observer separately.

(To be continued.)

THE SPROUL OBSERVATORY ECLIPSE EXPEDITION.

By JOHN A. MILLER.

The eclipse expedition from Sproul Observatory of Swarthmore College was located at Yerbanis, a small Mexican village about half way between the city of Torreon and the city of Durango in the state of Durango, Mexico. Two considerations led to the choice of this location. The first was that the regions in and near lower California and Catalina were to be occupied by a great number of very excellently equipped expeditions and it seemed unwise to add another; the second was to locate as far east of these expeditions as was possible, with the hope that an intercomparison of eastern and western plates might show motion in the corona. Accordingly we went as far east as in our judgment we dared go because of the prevailing clouds that come from the Gulf of Mexico at that season of the year. The reports of the Mexican Commission and that of the Eclipse Committee, and information obtained by correspondence led us to believe that Yerbanis was in an arid region and the probability of clear weather there was rather large. It turned out, however, that for this year there were more clouds there than we had anticipated. By actual observations it was found that at the time of the eclipse (2:34 P. M.) half the afternoons were clear enough to photograph an eclipse during the last month that we were there. There was, however, considerable cloudy weather and the cloudiness increased as the season wore on, and on the Friday and Saturday preceding the eclipse it rained hard and almost incessantly. From nine to ten on the morning of the eclipse day a torrential rain fell. At 10 o'clock a stream of water one-half inch deep was flowing over every square inch of our camp, after which it cleared somewhat. At the beginning of totality thin clouds were moving rapidly over the region of the eclipsed sun but the last half of totality occurred in a clear sky. We were able to carry out our entire program.

The installation included four cameras of 65 ft., 104″, 61″, and 38″ focal length respectively used for photographing the corona. The 65

ft. camera was mounted as the Lick Observatory observers have mounted their long focus cameras since 1893. The other cameras were mounted on a polar axis driven by a sector. Twenty-five photographs of corona were made with these instruments, the time of exposure varying from two seconds to 64 seconds. These photographs turned out well. They seemed not to have been hurt by the clouds. The 32 second exposure with the 38″ focal length shows extension of the

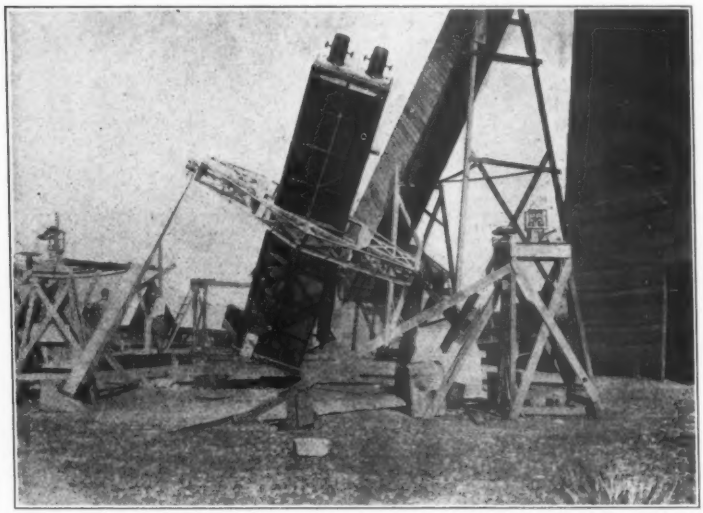
4 3 2 1

The Eclipse Station of the Sproul Observatory Expedition at Yerbanís, Mexico. The tents in which the party lived were to the left of the picture shown.

1. The Tower of the 65-foot Camera.
2. The "Twin Einstein Camera."
3. The single Einstein Camera.
4. A polar axis carrying two grating spectrographs, one Etalon Interferometer and a motion picture camera.

corona to three diameters from the margin of the sun. The corona is of the usual sun-spot minimum type. The polar streamers at both poles are very long and very well defined but rather faint. The north polar streamers can be traced more than a half diameter of the sun from its surface. They are very well defined and are longer but less bright than those around the southern pole. The corona on the

eastern side of the sun is very simple and much less complex than coronas usually are, although there are present there three rather large quiescent prominences. Long streamers may easily be traced to the sun's limb even on a 55-second exposure with the 65 ft. camera. In the southwest quadrant of the sun the corona is very complex showing several regions somewhat similar to those of the corona of 1918, but not so simple, and the outer corona on this side is not nearly so simple as the corona on the eastern side of the sun. Very few spots were visible on the sun for the weeks that immediately preceded the eclipse.

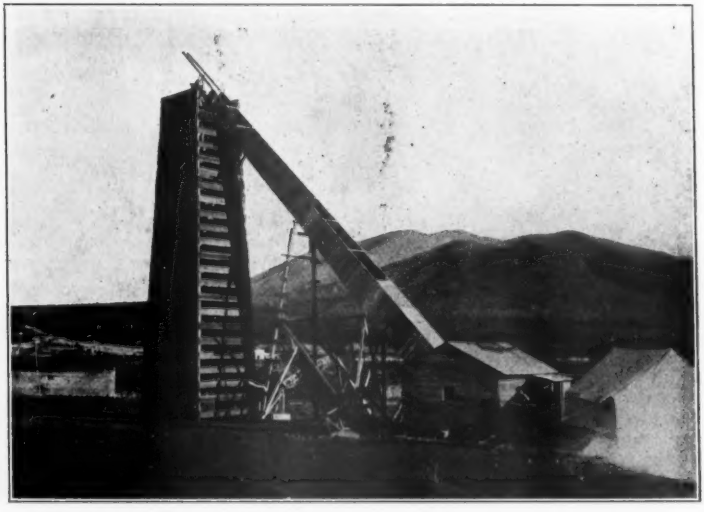


THE "TWIN EINSTEIN CAMERA."

We also mounted three cameras of 15 ft. focal length and 6¼" aperture with which to test the Einstein effect. The lenses of these cameras are quadruplet lenses and cover well an 18" x 18" plate. Two of these cameras were mounted on the same polar axis and with tubes rigidly lashed together. We denominated them as the "twin Einstein" cameras and with these two cameras we photographed the eclipse field, then shifted in declination 10 degrees and photographed during the eclipse a comparison field upon the same plate. We made two such plates in each camera. After this program had been arranged and those cameras constructed, Professor Charles Lane Poor of New York asked us to have constructed a single camera that carried a lens exactly like the ones in the twin camera and to expose plates in it as follows: To take a comparison field on a plate the night before the eclipse; photograph the eclipse field during the eclipse; and then make very short exposures on the moon. He proposed to use the diameter

of the moon as a scale of these plates, this scale to be checked by the comparison field made the night before. With this camera three photographs were made.

On another polar axis were mounted two spectrographs; one of 34″ focal length with which we tried to get the flash spectrum in the infrared and a second grating with which we hoped to get the flash spectra from λ 5000 to about λ 3400. Also we mounted an Étalon interferometer for determining rotation of the corona.



THE 65-FOOT CAMERA UNDER CONSTRUCTION.

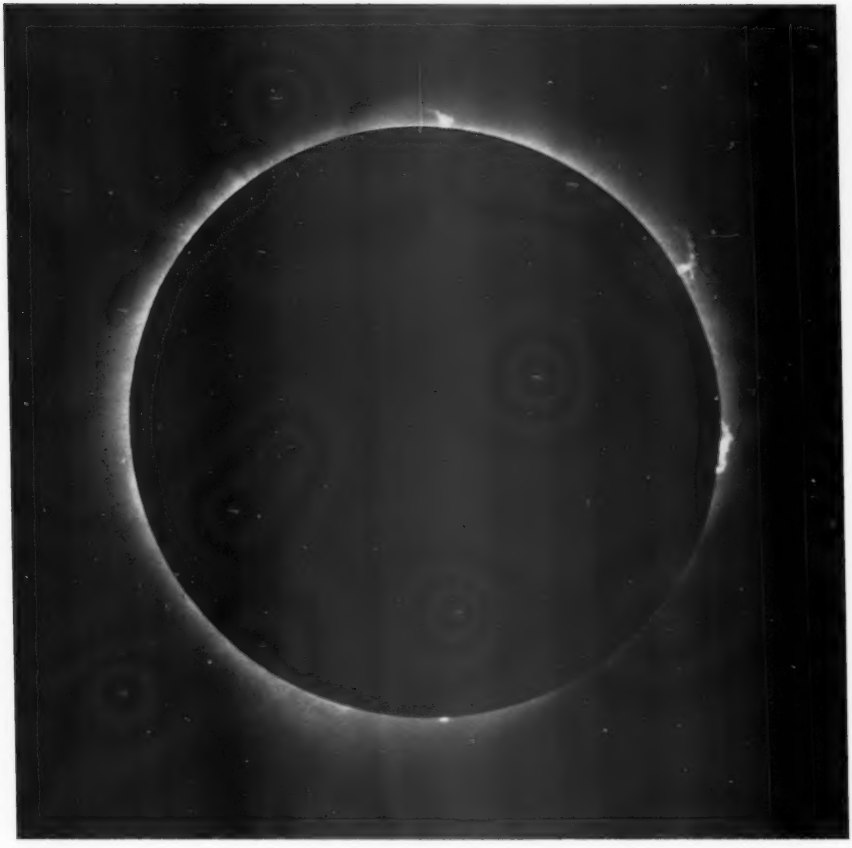
The thin clouds over the sky at the beginning of the eclipse seem not to have affected the quality of the corona. It is likely, I think, on the Einstein plates that the number of faint stars that were secured in the time at our disposal is somewhat less than we would have gotten had the clouds not prevailed. The plates have not yet been examined closely enough to decide how many stars really have been photographed on them.

The Pathé Exchange sent one of their most skillful men to the camp. He remained there during our entire stay and photographed with the motion camera the preparations for the eclipse that seemed interesting to him such as the mounting and adjustment of the instruments and made an exposure with the motion camera during the entire time of the eclipse from the first contact to the last. I have never seen these pictures but the college will come into possession of copies of them and our arrangement with the Pathé people permits us to lend them to any educational institution which might be interested in them.

PLATE XXXIV.

PHOTOGRAPH OF THE SOLAR CORONA, SEPTEMBER 10, 1923.
Taken by the Mexican National Observatory Eclipse Expedition at Yerbanís, Mexico, with the 6-meter camera. Exposure 50 seconds.

PLATE XXXV.



PHOTOGRAPH OF THE SOLAR CORONA AND PROMINENCES, SEPTEMBER 10, 1923.

Taken by the Mexican National Observatory Eclipse Expedition at Yerbanís, Mexico, with the 19-meter camera. Exposure 20 seconds. Reduced to about half scale.

We attempted to obtain a photographic record of the shadow band phenomenon. We marked upon a sheet a north and south line, and a scale marked in feet, and we photographed with a very rapid motion picture camera this sheet as the shadow bands passed over it, and also on the same film a watch beating seconds, hoping to get thereby the distance apart of these bands, and the direction and the velocity with which they were traveling. The shadow bands turned out to be very faint. I have not yet seen the film made by this camera.

The personnel of the expedition consisted of the writer and Mrs. Miller, Professor and Mrs. Marriott and Professor Wright of Swarthmore; Professor Curtis of Allegheny; Professor Alter of Kansas; Professor Long of Franklin and Marshall; three Swarthmore students, Messrs. Williams, Clothier and Sharples; two Harvard students, Messrs. Rubel and Powell; Max B. Miller, Jr., of New York; and our mascot, Elizabeth Marriott, the four-year-old daughter of Professor and Mrs. Marriott.

Swarthmore, Pa., October 18, 1923.

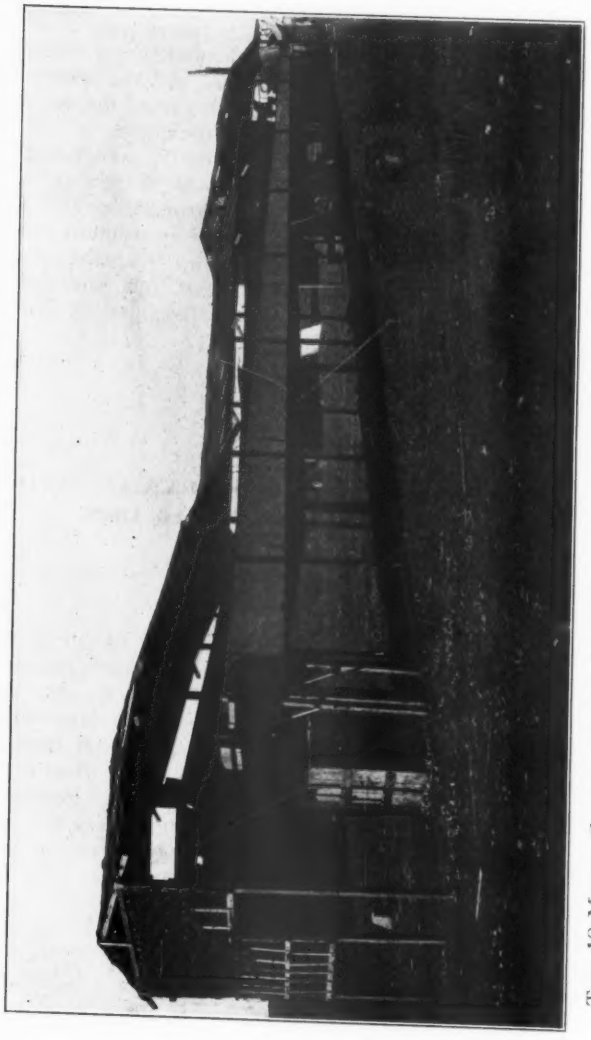
THE ECLIPSE EXPEDITIONS OF THE MEXICAN NATIONAL OBSERVATORY, SEPTEMBER 10, 1923.

By JOAQUIN GALLO.

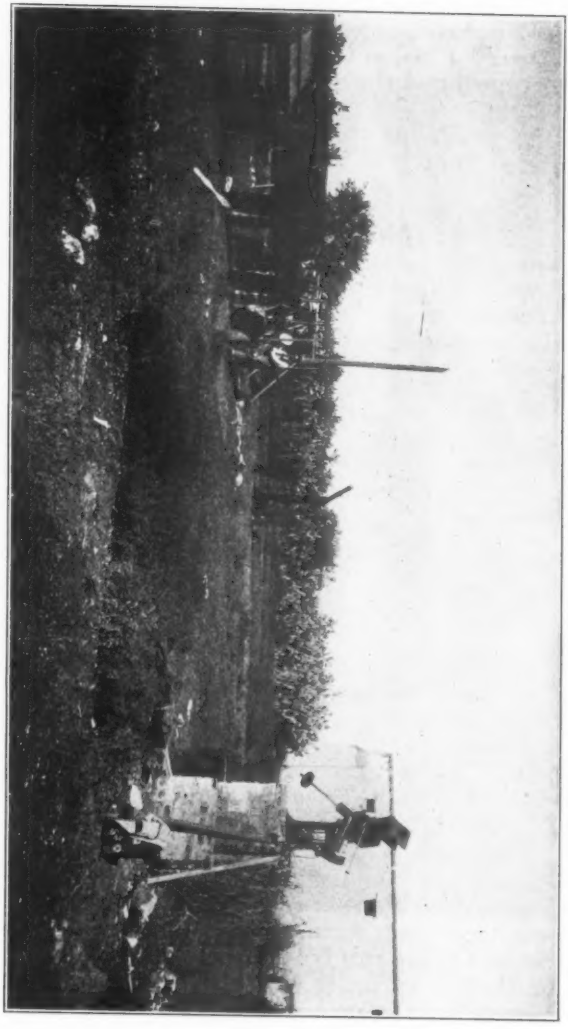
I have the pleasure to send you a brief statement of our results in Yerbanis and also in Laguna Seca near Charcas, San Luis Potosi.

The members of the expedition in Yerbanis were, Messrs.. Miguel Chávez Orozoo, Luis Segura, Ramon Alva, Antonio Salazar and myself in charge of the Expedition. We used a coelostat with three mirrors controlled by an electric pendulum, one object glass of 18.85 meters, another one of 6 meters and a small one of 2 meters focal length with a grating spectrograph. With the large camera Mr. Segura obtained six plates showing the prominences and a beautiful corona. With the 6 meters, Mr. Julio Prieto, who was invited to help us, obtained 8 plates showing also the coronal streamers. No result was obtained with the spectrograph; the moving picture camera was handled by Messrs. Alva and Salazar, and they got a very interesting film of the whole phenomenon showing the corona also.

The sky was not very clear in the morning of the 10th. We had a heavy shower at 9 o'clock and it was not until eleven that the sky began to clear. Some minutes before totality a cloud was in front of the sun, and until after totality began. The sky was too bright on account of the clouds for us to see the shadow bands. Prominences were not seen with the eye but with a small telescope their color was whitish and I



THE 19-METER CAMERA OF THE MEXICAN NATIONAL OBSERVATORY ECLIPSE EXPEDITION AT YERBANIS, MEXICO.



THE MEXICAN NATIONAL OBSERVATORY ECLIPSE CAMP AT LAGUNA SECA, MEXICO.

could see the chromosphere at third contact. I hoped to get some star images on the plates of the six meter camera but I don't believe that we got very many stars for the reason already stated.

The geographical position of the Station was $+24^\circ\ 43'\ 55'' \pm 1''$ and $6^h\ 55^m\ 22^s.4 \pm 0^s\ 1$ west of Greenwich.

The Meteorological observations made in Yerbanis were not of any value due to the bad conditions. The actinograph, however, shows the decrease of temperature, but I can not compare it because of the presence of the cloud.

The Leguna Seca Party in charge of Professor J. M. Chacon, with assistants E. Ortega, F. Estanol and J. Tapia, secured five plates with an object glass of 8 meters focal length and some pictures of the partial phase with a photoheliograph. At this place the sky was better than at Yerbanis but a haze prevented securing better results.

Under separate mail I am sending you a picture of our camera at Yerbanis, two pictures with the 19 meter camera, two with the 6 meter and two others of Laguna Seca and a partial view of the camp in that place.

REPORT ON MARS, NO. 26.

By WILLIAM H. PICKERING.

The Axis of Mars.

In order to secure quantitative results with regard to the shifting of the Martian detail over the surface of the planet, both with the seasons and also independently of them, it is necessary to obtain accurate measures of various reference points on the surface, in both longitude and latitude. To do this we must know the position of the polar axis of the planet with considerable precision. Its position was determined by Schiaparelli and his predecessors by means of observations of the polar caps, and this method has been universally adopted since his time. The position used at present in the Ephemeris was determined by Lowell and Crommelin, and is there given to seconds of arc and time. Such accuracy is deceptive however, and is by no means justified by the accuracy of the results, since the error appears to be expressed in degrees, as we shall presently see.

Many years ago I suggested to Lowell that instead of using the polar caps, he should use exclusively latitudes and longitudes of points on the surface of the planet. The idea however did not appeal to him. The objection to using the polar caps is well illustrated by observations made in the autumn of 1913, and very evidently in the summer of 1922, when although the northern pole of Mars was inclined to-

PLATE XXXVI

PHOTOGRAPH OF THE SOLAR CORONA, SEPTEMBER 10, 1923

Taken by the Mexican National Observatory Eclipse Expedition at Laguna Seca, Mexico, with the 8-meter camera. Exposure 20 seconds. Reduced to five-sixths scale.

wards us at an angle of 9°, and the outline of that portion of the northern polar cap which was visible to us should have been distinctly elliptical, yet its southern boundary was sometimes clearly seen as a straight line going directly across the disk from limb to terminator. The explanation was obvious. As any given point of the cap was brought by the rotation of the planet to the central meridian of the disk, the snow or frost melted, and did not form again until the following afternoon and night. Consequently the latitude of the cap was higher at Martian sunset than it was at sunrise. Moreover it would always be so, even if it were not detected. This difference was also exhibited throughout the month of June 1922 by means of a comparison of position angles taken on the snow with those based on the Ephemeris.

That the daily melting of the snow or frost should have been sufficient to have made itself visible in this manner is certainly surprising, and clearly indicates not only the thinness of the snow, but also why the error of any determination of the location of the pole based on such an observation would be considerable. It must also be remembered that these observations cannot be continued throughout the Martian orbit, in which case the errors might possibly neutralize one another. At certain seasons neither cap is visible, the one turned towards the earth being hidden beneath Martian clouds. The southern cap is very eccentric, and when it is small is hidden behind the planet in some longitudes, and situated on the disk away from the limb in others. When the cap is large the melting is found to be considerable, with consequent displacement in latitude. The northern cap which is best suited for locating the axis of the planet is sufficiently small for this purpose for only a few months of the year.

While the position of the polar axis could be determined either by latitudes or by longitudes of points on the disk, measured in different portions of the planet's orbit, yet the former are much the better suited for our purpose. In order to use the method of longitudes it would be necessary to measure points located in high latitudes. But such points are seldom well defined, and moreover in general have a very distinct and considerable proper motion, that is to say they shift about over the surface of the planet in an irregular manner. The method by means of latitudes on the other hand requires the use of points near the planet's equator, and these can always be observed near the centre of the disk, under the most favorable conditions. While there is evidence that these also exhibit a considerable motion in latitude that can be measured from the earth, yet we shall presently show that the extent of this motion may be greatly reduced by a simple change of the position of the polar axis from that given in the Ephemeris.

If we could find a single point on the surface of the planet whose position we knew to be stationary, or if we could find a dozen whose

proper motions lay within the limits of accuracy of our present observations, all would be well. Unfortunately however such is not the case. Thirteen different points have been selected for accurate observation which were sufficiently distinct to be clearly recognized on several different nights, at each of the past apparitions of the planet.

In order to understand the method that is employed to locate the planet's axis, we must note first that all that is required is simply to determine the right ascension and declination of the point in which it

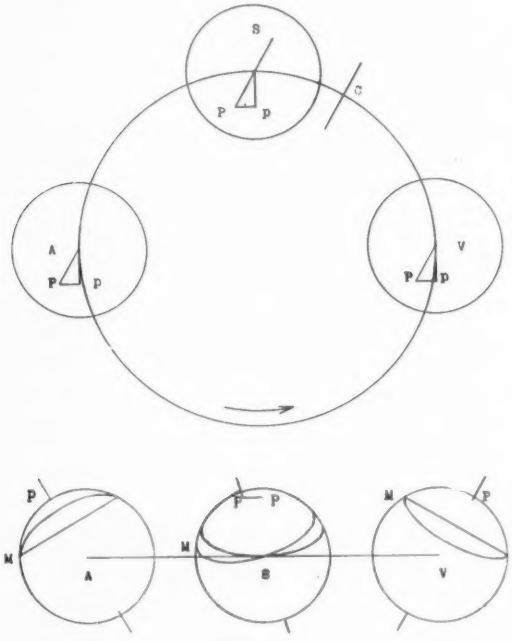


FIGURE 1.

would intersect the celestial sphere. In order to see how we have determined this point, in Figure 1 let the large circle represent the planet's orbit as seen from the north, and the small circles V and A the planet itself at its assumed vernal and autumnal equinoxes. S shows its position at the summer solstice. The point P in each circle indicates its true north pole, and p its pole according to the Ephemeris. The distance between these is greatly exaggerated in the figure, since in point of fact they nearly coincide. The center of each small circle indicates the pole of the planet's orbit. The latitude according to the Ephemeris, for any observed point on any given date is readily calculated from p by means of the tables. The three circles below indicate

the appearance of the planet in the three positions as seen from the sun.

In the case that P coincided with p, then at the two equinoxes a point M would describe a straight line across the disk. If P were located, as shown in the drawing, to the left of p, M would then describe a curved course, its latitude being to the south of that computed, in the Martian spring, and to the north of the computed value in the autumn. At the summer solstice on the central meridian the two values would coincide, although the actual course described would not coincide with the theoretical one. Observations of latitude and longitude can only be made with accuracy when the points observed are near this meridian. The effect of a displacement of the true pole P from that of the Ephemeris, as shown in the upper portion of the drawing, is to shift the summer solstice backwards on the orbit to C, and to carry the other solstice and equinoxes backwards with it through the same number of degrees.

FIGURE 2.

To determine the inclination of the planet's axis to its orbit, which gives the distance between their two poles, observations must be secured at the solstices. In Figure 2 let the line $S\,W$ represent the plane of the planet's orbit, and the two circles its position at the solstices. P and p represent as before the true pole and that of the Ephemeris. Let M be a point on the true equator. Then at the summer solstice S, its observed latitude when computed, will appear to be south of its latitude when observed at the winter solstice. This then is the result when the assumed inclination of the planet's axis to the axis of its orbit is too small, and we may thus determine completely the location of the planet's axis in space.

While for the sake of simplicity we have referred these observations to the sun, and to the equinoxes and solstices, yet the position of the planet's axis may be determined from any other point in space by correcting the position of Mars for the location of the observer. In practice the tangential shift of the planet's pole around the pole of its orbit is determined when the planet is near its geocentric equinoxes, if we may so call them, that is those measured with regard to the earth, instead of with regard to the sun. Similarly the inclination, or radial shift, is determined when its poles are turned alternately towards us, in analogy to the Martian solstices. These positions of the planet are given to us directly by the Ephemeris, as we shall presently see.

Let us turn now to our actual results. Our observations so far have extended through five apparitions of the planet, during which time it has been observed through a range of geocentric longitudes of 176°. This excludes all those observations where the diameter of the disk was less than 10″. While the observations will not really be completed until after the apparition of 1928, yet since the future is always uncertain, and an inspection of our results leads us to believe that the later observations would not add materially to the accuracy of our conclusions, it has been thought best to publish them at once for the benefit of other observers. It is believed that any errors that may exist in them are unlikely to affect materially any future observations until our present standard of acruracy is very considerably increased.

The latitudes and longitudes of about ninety points on the surface of the planet have recently been computed and catalogued, and from these the thirteen points have been selected which have been used in the present investigation. Of the two methods of determining latitudes on Mars, by means of the micrometer and by means of drawings, as has been shown in Reports No. **13** and **18**, there is little to choose in accuracy. The objection to the use of the micrometer however, especially for the present kind of investigation, is because of the large systematic errors which occur in planetary measures made with this instrument when small distances of only a few seconds are involved. These would be most marked when the point observed passed well to the north or south of the center of the disk. These errors as has been already shown in H. A. **32**, 139, may well overbalance the somewhat larger accidental errors that occur in the drawings.

In every case four or more drawings, made on four different nights have been measured, of each of the selected points, at each equinox. At the one solstice observed, eight observations were secured of each point. In order that a drawing may be suitable for this investigation the point should lie on, or within a few degrees of the central meridian, the seeing should be recorded as satisfactory, that is in general as not less than 7, and the diameter of the disk should be as great as 10″. In only two instances was it found necessary to measure a smaller disk. In all 131 drawings have been used in this investigation. On many of them two or more points have been measured. The total number of measured positions recorded in the 208 entries in Table I is 219.

It will be noticed that the name of each station in the table is preceeded by a number which indicates its position in the catalogue, and is followed by the letters N, S, p, f, c, or m, indicating that the point observed was the extreme north, south, preceding, following, center, or middle. The first column gives the date of the drawing, or drawings in case there are two or more of them made on the same night, the second gives the value of $A_{\oplus}$ taken from the Ephemeris, and the third the latitude of the station as measured from the drawing, cor-

TABLE I.

SELECTED STATIONS.

8 Thymiamata S. f.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 2	24.9	—0.4	+2.4	+3.4
'14 Jan. 4	16.7	—3.5	—0.6	+0.4
'14 Jan. 5	16.3	—4.5	—1.6	—0.6
'14 Jan. 6	16.0	—7.1	—4.2	—3.2
Mean		—3.87	—1.00	
'18 Feb. 17	94.1	—3.3	—3.3	+0.2
'18 Mar. 16	84.9	—4.7	—4.2	—0.7
'18 Mar. 22	82.4	—1.8	—1.2	+2.3
'18 Mar. 23	82.0	—4.5	—3.9	—0.4
'18 Mar. 24	81.6	—5.5	—4.9	—1.4
'20 May 10	118.4	—1.7	—2.9	+0.6
'20 May 11	118.2	—2.8	—4.0	—0.5
'20 May 12	117.9	—2.3	—3.5	0.0
Mean		—3.32	—3.49	
'22 June 2	174.6	—1.5	—4.5	—3.1
'22 July 4	166.9	+3.4	+0.5	+1.9
'22 July 6	166.6	+3.7	+0.8	+2.2
'22 July 9	166.3	+0.7	—2.2	—0.8
Mean		+1.58	—1.35	

10 Aromatum S. p.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 4	24.7	—2.7	+0.1	—0.4
'14 Jan. 4	16.7	+1.9	+4.8	+4.3
'14 Jan. 5	16.3	—5.2	—2.3	—2.8
'14 Feb. 8	8.3	—3.6	—0.6	—1.1
Mean		—2.40	+0.50	
'18 Feb. 12	95.0	+1.8	+1.7	+3.3
'18 Mar. 16	84.9	—2.3	—1.8	—0.2
'18 Mar. 22	82.4	0.0	+0.6	+2.2
'18 Apr. 21	74.9	—3.0	—2.0	—0.4
'18 Apr. 28	74.9	+2.6	+3.6	+5.2
'20 Mar. 4	132.6	—4.1	—6.0	—4.4
'20 May 6	119.6	—3.4	—4.7	—3.1
'20 May 8	119.0	—2.8	—4.1	—2.5
Mean		—1.40	—1.59	
'22 July 4	166.9	+3.4	+0.5	+1.3
'22 July 6	166.6	+3.6	+0.7	+1.5
'22 Aug. 11	170.0	+0.7	—2.2	—1.4
'22 Sept. 15	184.0	+0.9	—2.1	—1.3
Mean		+2.15	—0.78	

11 Acidalium S.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 31	18.1	+40.3	+43.2	—0.8
'14 Jan. 4	16.7	+42.5	+45.4	+1.4
'14 Jan. 5	16.3	+39.5	+42.4	—1.6
'14 Feb. 10	8.2	+41.8	+44.8	+0.8
Mean		+41.02	+43.95	
'18 Feb. 9	95.3	+44.9	+44.8	+2.4
'18 Feb. 12	95.0	+45.9	+45.8	+3.4
'18 Mar. 13	86.2	+39.3	+39.7	—2.7
'18 Mar. 16	84.9	+39.3	+39.8	—2.6
'18 Mar. 22	82.4	+42.0	+42.6	+0.2
'18 Apr. 21	74.9	+41.8	+42.8	+0.4
'18 Apr. 28	74.9	+44.3	+45.3	+2.9
'20 Jun. 21	118.6	+39.8	+38.5	—3.9
Mean		+42.16	+42.41	
'22 May 26	176.1	+47.4	+44.4	+4.8
'22 Jun. 30	167.6	+46.4	+43.5	+3.9
'22 Jul. 4	166.9	+40.3	+37.4	—2.2
'22 Aug. 8	169.2	+35.8	+32.9	—6.7
Mean		+42.48	+39.55	

12 Niliacus S.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 2	24.9	+29.9	+32.7	+4.9
'13 Dec. 30	18.5	+21.0	+23.9	—3.9
'13 Dec. 31	18.1	+20.8	+23.7	—4.1
'14 Jan. 5	16.3	+27.9	+30.8	+3.0
Mean		+24.90	+27.78	
'18 Feb. 6	95.5	+26.4	+26.3	—2.2
'18 Feb. 9	95.3	+24.5	+24.4	—4.1
'18 Feb. 12	95.0	+30.2	+30.1	+1.6
'18 Mar. 13	86.2	+27.8	+28.2	—0.3
'18 Mar. 16	84.9	+26.5	+27.0	—1.5
'18 Mar. 22	82.4	+27.2	+27.8	—0.7
'18 Apr. 21	74.9	+27.9	+28.9	+0.4
'18 Apr. 28	74.9	+34.1	+35.1	+6.6
Mean		+28.08	+28.48	
'22 Apr. 29	177.1	+31.4	+28.4	—0.1
'22 May 26	176.1	+34.2	+31.2	+2.7
'22 Jun. 2	174.6	+30.7	+27.7	—0.8
'22 Jun. 30	167.6	+29.4	+26.5	—2.0
Mean		+31.42	+28.45	

TABLE I—*Continued.*

23 Solis c.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 30	18.5	—28.6	—25.7	+0.6
'13 Dec. 31	18.1	—28.4	—25.5	+0.8
'14 Feb. 5	8.5	—29.3	—26.3	0.0
'14 Feb. 7	8.4	—30.8	—27.8	—1.5
Mean		—29.28	—26.32	
'18 Feb. 6	95.5	—22.5	—22.6	—4.0
'18 Feb. 9	95.3	—25.1	—25.2	—1.4
'18 Mar. 13	86.2	—24.9	—24.5	—2.1
'18 Mar. 14	85.8	—28.8	—28.4	+1.8
'18 Apr. 20	75.0	—25.9	—24.9	—1.7
'20 Mar. 27	132.1	—27.7	—29.6	+3.0
'20 May 5	119.9	—27.2	—28.5	+1.9
'20 May 6	119.6	—27.5	—28.8	+2.2
Mean		—26.20	—26.56	
'22 May 25	176.2	—29.1	—32.1	+1.2
'22 Jun. 29	167.8	—26.8	—29.7	—1.2
'22 Jun. 30	167.6	—27.2	—30.1	—0.8
'22 Jul. 1	167.4	—28.6	—31.5	+0.6
Mean		—27.92	—30.85	

41 Titanum N.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 29	18.7	—19.5	—16.6	+1.6
'14 Jan. 21	11.2	—19.0	—16.0	+2.2
'14 Jan. 27	9.8	—23.5	—20.5	—2.3
'14 Feb. 1	9.0	—22.7	—19.7	—1.5
Mean		—21.18	—18.20	
'18 Feb. 1	95.6	—14.7	—14.8	+4.4
'18 Mar. 5	89.3	—15.7	—15.5	+3.7
'18 Mar. 6	89.0	—21.2	—21.0	—1.8
'18 Apr. 8	76.8	—18.8	—17.9	+1.3
'20 Feb. 14	128.8	—17.4	—19.1	+0.1
'20 Apr. 23	124.2	—21.4	—22.9	—3.7
'20 Apr. 28	122.3	—21.6	—23.0	—3.8
'20 Jun. 1	115.6	—18.5	—19.6	—0.4
Mean		—18.66	—19.22	
'22 May 19	177.1	—16.3	—19.3	—2.2
'22 Jun. 17	170.6	—10.8	—13.7	+3.4
'22 Jun. 20	169.8	—13.9	—16.8	+0.3
'22 Jun. 21	169.6	—15.7	—18.6	—1.5
Mean		—14.18	—17.10	

50 Elysium N.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 16	22.7	+33.9	+36.8	+0.6
'13 Dec. 17	22.5	+34.4	+37.3	+1.1
'14 Jan. 18	12.0	+31.9	+34.9	—1.3
'14 Jan. 20	11.5	+32.9	+35.9	—0.3
Mean		+33.28	+36.22	
'18 Mar. 3	90.1	+35.8	+36.0	+1.8
'18 Mar. 5	89.3	+35.4	+35.6	+1.4
'18 Apr. 4	77.8	+31.0	+31.8	—2.4
'18 Apr. 5	77.6	+33.1	+33.9	—0.3
'18 May 9	76.1	+35.7	+36.6	+2.4
'18 May 14	77.1	+31.5	+32.3	—1.9
'20 Apr. 20	125.3	+36.5	+34.9	+0.7
'20 May 29	115.6	+33.3	+32.2	—2.0
Mean		+34.04	+34.16	
'22 Jun. 13	171.7	+39.1	+36.2	—0.3
'22 Jun. 14	171.4	+41.0	+38.1	+1.6
'22 Jul. 21	166.2	+38.1	+35.2	—1.3
'22 Jul. 22	166.3	+39.5	+36.6	+0.1
Mean		+39.42	+36.52	

52 Elysium S.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'14 Jan. 18	12.0	+10.9	+13.9	+2.7
'14 Jan. 20	11.5	+ 8.1	+11.1	—0.1
'14 Feb. 24	8.8	+ 8.4	+11.4	+0.2
'14 Feb. 25	9.0	+ 5.5	+ 8.5	—2.7
Mean		+ 8.22	+11.22	
'18 Mar. 1	90.8	+16.8	+16.9	+2.5
'18 Mar. 3	90.1	+14.2	+14.4	0.0
'18 Mar. 5	89.3	+15.3	+15.5	+1.1
'18 Apr. 4	77.8	+14.0	+14.8	+0.4
'18 Apr. 5	77.6	+10.5	+11.3	—3.1
'18 May 9	76.1	+13.1	+14.0	—0.4
'20 Apr. 20	125.3	+17.3	+15.7	+1.3
'20 May 29	115.6	+14.0	+12.9	—1.5
Mean		+14.40	+14.44	
'22 Jun. 13	171.7	+17.3	+14.4	+0.4
'22 Jun. 14	171.4	+17.6	+14.7	+0.7
'22 Jun. 15	171.2	+18.0	+15.1	+1.1
'22 Jul. 21	166.2	+14.5	+11.6	—2.4
Mean		+16.85	+13.95	

TABLE I—*Continued.*

63 Nepenthes m.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'13 Dec. 10	24.0	+11.6	+14.4	+2.8
'13 Dec. 12	23.6	+ 6.6	+ 9.4	—2.2
'14 Jan. 15	12.9	+ 8.1	+11.1	—0.5
'14 Jan. 18	12.0	+ 8.6	+11.6	0.0
Mean		+ 8.72	+11.62	
'18 Jan. 22	94.8	+11.8	+11.8	—1.5
'18 Feb. 18	93.9	+12.3	+12.3	—1.0
'18 Feb. 19	93.7	+10.5	+10.5	—2.8
'18 Feb. 27	91.5	+10.7	+10.8	—2.5
'18 Apr. 4	77.8	+14.3	+15.1	+1.8
'18 May 5	75.5	+16.6	+17.5	+4.2
'18 May 9	76.1	+15.6	+16.5	+3.2
'20 May 27	115.6	+12.8	+11.7	—1.6
Mean		+13.08	+13.28	
'22 May 9	177.6	+15.8	+12.8	+0.6
'22 Jun. 13	171.7	+11.3	+ 8.4	—3.8
'22 Jul. 13	166.1	+15.9	+13.0	+0.8
'22 Jul. 17	166.1	+17.6	+14.7	+2.5
Mean		+15.15	+12.22	

74 Syrtis N.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'14 Jan. 15	12.9	+23.8	+26.8	+2.4
'14 Jan. 17	12.3	+22.6	+25.6	+1.2
'14 Jan. 18	12.0	+21.7	+24.7	+0.3
'14 Feb. 15	8.2	+17.5	+20.5	—3.9
Mean		+21.40	+24.40	
'18 Feb. 16	94.3	+25.9	+25.9	+0.4
'18 Feb. 18	93.9	+25.8	+25.8	+0.3
'18 Feb. 19	93.7	+23.2	+23.2	—2.3
'18 Feb. 27	91.5	+22.0	+22.1	—3.4
'18 Apr. 3	78.1	+25.9	+26.7	+1.2
'18 Apr. 4	77.8	+29.9	+30.7	+5.2
'18 May 2	75.1	+23.8	+24.8	—0.7
'18 May 5	75.5	+23.6	+24.5	—1.0
Mean		+25.01	+25.46	
'22 Jun. 5	173.8	+26.6	+23.6	—2.6
'22 Jun. 13	171.7	+30.4	+27.5	+1.3
'22 Jul. 13	166.1	+29.4	+26.5	+0.3
'22 Jul. 17	166.1	+30.0	+27.1	+0.9
Mean		+29.10	+26.18	

82 Hammonis S. p.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'14 Jan. 6	16.0	—19.7	—16.8	—2.2
'14 Jan. 10	14.6	—16.2	—13.2	+1.4
'14 Jan. 17	12.3	—19.0	—16.0	—1.4
'14 Feb. 12	8.2	—15.3	—12.3	+2.3
Mean		—17.55	—14.58	
'18 Feb. 17	94.1	— 9.9	— 9.9	+2.0
'18 Mar. 21	82.8	—12.4	—11.8	+0.1
'18 Mar. 22	82.4	—15.2	—14.6	—2.7
'18 Apr. 3	78.1	—10.4	— 9.6	+2.3
'18 Apr. 28	74.9	—10.8	— 9.8	+2.1
'20 Mar. 13	133.2	—14.5	—16.4	—4.5
'20 May 15	117.2	—13.0	—14.2	—2.3
'20 May 19	116.4	— 7.4	— 8.6	+3.3
Mean		—11.70	—11.86	
'22 May 3	177.4	— 5.7	— 8.7	+1.1
'22 Jul. 9	166.3	— 8.0	—10.9	—1.1
'22 Jul. 11	166.2	— 8.0	—10.9	—1.1
'22 Aug. 17	171.8	— 5.7	— 8.7	+1.1
Mean		— 6.85	— 9.80	

86 Ismenius c.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'14 Jan. 10	14.6	+44.0	+47.0	—1.5
'14 Jan. 11	14.2	+48.2	+51.2	+2.7
'14 Jan. 12	13.9	+46.8	+49.8	+1.3
'14 Feb. 15	8.2	+43.0	+46.0	—2.5
Mean		+45.50	+48.50	
'18 Feb. 17	94.1	+47.3	+47.3	+1.9
'18 Mar. 21	82.8	+42.5	+43.1	—2.3
'18 Mar. 22	82.4	+41.6	+42.2	—3.2
'18 Apr. 3	78.1	+42.7	+43.5	—1.9
'18 Apr. 28	74.9	+47.4	+48.4	+3.0
'18 Jun. 3	83.4	+46.4	+46.9	+1.5
'18 Jun. 9	85.9	+45.5	+45.9	+0.5
'18 Jun. 10	86.4	+45.6	+46.0	+0.6
Mean		+44.88	+45.41	
'22 May 3	177.4	+47.5	+44.5	—0.4
'22 Jun. 4	174.1	+46.9	+43.9	—1.0
'22 Jul. 9	166.3	+49.0	+46.1	+1.2
'22 Jul. 11	166.2	+47.9	+45.0	+0.1
Mean		+47.82	+44.88	

TABLE I—*Continued.*

89 Edom S.

Date	$A_\oplus$	B	B′	ΔB′
	°	°	°	°
'14 Jan. 4	16.7	— 8.9	— 6.0	—1.7
'14 Jan. 6	16.0	—10.2	— 7.3	—3.0
'14 Jan. 10	14.6	— 2.9	+ 0.1	+4.4
'14 Feb. 14	8.2	— 7.1	— 4.1	+0.2
Mean		— 7.28	— 4.32	
'18 Feb. 17	94.1	— 4.9	— 4.9	—2.5
'18 Mar. 16	84.9	+ 0.3	+ 0.8	+3.2
'18 Mar. 21	82.8	— 2.9	— 2.3	+0.1
'18 Mar. 22	82.4	— 3.4	— 2.8	—0.4
'18 Mar. 24	81.6	— 6.8	— 6.2	—3.8
'18 Apr. 28	74.9	+ 0.3	+ 1.3	+3.7
'20 Mar. 4	132.6	+ 1.0	— 0.9	+1.5
'20 May 12	117.9	— 3.1	— 4.3	—1.9
Mean		— 2.44	— 2.41	
'22 Apr. 29	177.1	0.0	— 3.0	+0.5
'22 May 3	177.4	— 3.4	— 6.4	—2.9
'22 Jun. 2	174.6	0.0	— 3.0	+0.5
'22 Jul. 9	166.3	+ 1.4	— 1.5	+2.0
Mean		— 0.50	— 3.48	

rected for the latitude of the center of the disk and for the phase when necessary. Means of these latitudes have been taken for each equinox, and for the summer solstice.

TABLE II.

REDUCTION OF OBSERVATIONS.

No.	Station	Vernal	Summer	V cor.	S cor.	S-V	A-S	Sun	Lat.
		°	°	°	°	°	°		°
8	Thymiamata S.	—2.72	—2.17	+0.18	—2.31	—2.49	+2.13	A A	— 1.18
10	Aromatum S. p.	—2.28	—1.28	+0.64	—1.45	—2.09	+0.81	A A	— 0.14
11	Acidalium S.	—0.73	+0.41	+2.20	+0.66	—1.54	—2.86	A W	+41.75
12	Niliacus S.	—3.26	—0.08	—0.34	+0.36	+0.70	—0.02	W W	+28.12
23	Solis c.	—0.68	+2.40	+2.26	+2.02	—0.24	—4.28	A W	—28.58
41	Titanum N.	—3.50	—0.98	—0.55	—1.57	—1.02	+2.12	A A	—17.65
50	Elysium N.	—3.07	—2.31	—0.15	—2.21	—2.06	+2.36	A A	+36.37
52	Elysium S.	—4.32	+1.86	—1.36	+1.86	+3.22	—0.50	W W	+12.58
63	Nepenthes m.	—3.22	+1.14	—0.30	+1.36	+1.66	—1.06	W W	+11.92
74	Syrtis N.	—3.85	—0.24	—0.89	+0.17	+1.06	+0.72	W A	+25.29
82	Hammonis S. p.	—5.35	+0.50	—2.39	+0.33	+2.72	+2.06	W A	—12.19
86	Ismenius c.	—1.16	—1.78	+1.81	—1.28	—3.09	—0.53	A W	+46.69
89	Edom S.	—3.39	+1.45	—0.42	+1.49	+1.91	—1.07	W W	— 3.90
		°	°	°	°				
Algebraic Mean		—2.887	—0.083	+0.053	—0.044				
				°	°				
Arithmetical Mean				±1.04	±1.31				

The difference between the latitudes at the vernal and at the autumnal equinoxes divided by two, with the proper sign attached, gives the latitude at the vernal equinox minus the mean. These numbers are entered in the third column of Table II. The latitude at the summer

solstice minus the mean latitude at the two equinoxes is entered in the fourth column. In Figure 3 both ordinates and abscissas represent latitudes, north and south. The intersection of the 0° co-ordinates indicates the mean latitude for each of the points observed. The abscissas taken from the third column of Table II therefore give the deviation in latitude at the vernal equinox in degrees from the mean, and the ordinates taken from the fourth column, the deviation at the summer solstice.

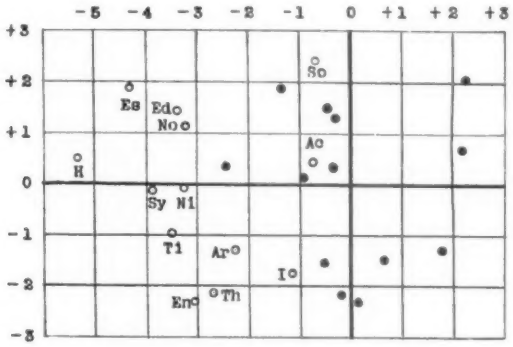


FIGURE 3.

If now any point could be found which was absolutely stationary on the planet, if it were accurately observed, and if the planet's axis were correctly located in space, then both of its co-ordinates would be zero. Since however none of these conditions appears to be fulfilled we shall assume that the mean of the two values at the vernal and autumnal equinoxes gives the true latitude for each point. The observed positions are indicated by the open circles, and the following abbreviations are used: Ac Acidalium S., Ar Aromatum S. p., Ed Edom S., En Elysium N., Es Elysium S., H Hammonis S. p., I Ismenius c., Ne Nepenthes m., Ni Niliacus S., So Solis c., Sy Syrtis N., Th Thymiamata S. f., Ti Titanum N.

It will be noticed in the first place that all of the stations are located to the left of the zero abscissa, indicating that, based on the Ephemeris, the latitude of every one of them appeared to be more southerly at the vernal equinox than at the autumnal. The average distance is about 3° (See third column of Table II). That is to say the difference in latitude of these points between the vernal and autumnal equinoxes averaged about 6°. This may be explained most simply, as we have seen, by supposing that the true north pole of the planet, as shown in Figure 1, is located 3° of a great circle to the left of the pole according to the Ephemeris. The alternative supposition is that all thirteen points moved northerly over the planet's surface between the vernal

and autumnal equinoxes an average distance of 218 miles, some more and some less.

We next notice that the mean position of the stations coincides pretty close with the 0° ordinate. This indicates that on the whole, they do not move very far north or south at the summer solstice, and accordingly that the adopted inclination of the planet's axis to the axis of the plane of its orbit 23° 59′ is very nearly correct. We must next recall that while the dates of the drawings that were measured were so selected as to be as near as possible to the dates required by theory, yet they necessarily were not identical with them. Therefore the plots of these points in the figure are approximate, but not quite accurate. In order to render them so, and at the same time to bring their mean positions nearer to the intersection of the zero co-ordinates, we may apply the formula

$$B' = B - C\cos(-A_{\oplus}) + D\sin(-A_{\oplus})$$

where B' is the mean of the latitudes at the two geocentric equinoxial points, B is the observed latitude of the station on each night taken from the third column of Table I, C and D are constants to be determined by successive approximation and $A_{\oplus}$ is the planetocentric right ascension of the earth, measured in the plane of the planet's equator from its vernal equinox, as given in the Ephemeris. The maximum numerical values of the third and fourth terms of the equation will lie at the planet's geocentric vernal equinox and summer solstice, that is to say, at those positions in its orbit where $A_{\oplus}$ equals 0° and 90° Since the algebraic means of the third and fourth columns of Table II are both negative, this necessarily makes the sign of the third term in the equation negative, and the fourth positive. Our equation may, however, more conveniently be written

$$B' = B - C\cos A_{\oplus} - D\sin A_{\oplus}.$$

It is believed that all future latitude determinations based on the present Ephemeris should be corrected by this formula. The numbers in the fourth column of Table I are computed by means of it, and their deviations from their mean value are given in the fifth. In this computation we have made $C = -3°.0$ and $D = -0°.2$. Correcting the resulting positions still further, we find that C should be $-2°.947$ or $-2°\ 57'$, and that D should be $-0°.256$ or $-15'$. Correction C therefore diminishes the accepted tangential angle of position of the pole with regard to the pole of its orbit, while correction D diminishes the radial position, or inclination of the axis to the orbital plane. In other words it increases the inclination of the axis of the planet to the axis of its orbit, changing it from the accepted value 23° 59′ to 24° 14′. It may be noted that the last four determinations of the inclination of the planet's axis, the only ones made since 1830, were by Schiaparelli

24° 42′, Lohse 23° 57′, Cerulli 24° 45′, and Lowell 23° 16′. Their mean value is 24° 10′.

In Figure 3 the blackened circles are plotted from the fifth and sixth columns of Table II, which are derived from the fourth column of Table I by the same process, already described, as was employed in deriving the two previous columns of Table II. These circles may be readily identified, since in each case their abscissas are about 3° greater than those of the corresponding open circles. The difference in their ordinates is the result of the application of the formula. Unlike the open circles, their positions are exact.

On viewing the figure, the question at once arises, having now corrected the results for the error in the location of the axis of the planet, how much of the remaining deviation from the zero co-ordinates is due to proper motions of the stations, both seasonal and from week to week, and how much to accidental errors of the observations themselves. This question can be answered only by two or more independent series of observations, either of drawings and micrometer measures by the same observer, or better still by different observers. It would seem that an investigation of the proper motions, and their classification was a subject that might add materially to our knowledge of the conditions prevailing on the surface of the planet. The probable errors of our observations of the thirteen points are entered in the second, third, and fourth columns of Table III, while the fifth column gives the means of the three preceding ones, and shows that the

TABLE III.

PROBABLE ERRORS OF THE STATIONS

Stations	Vernal	Summer	Autumnal	Mean	Equinoxes
	°	°	°	°	°
8 Thymiamata	±0.93	±0.24	±0.98	±0.72	±0.68
10 Aromatum	1.05	0.85	0.67	0.86	0.62
11 Acidalium	0.56	0.74	2.15	1.15	1.11
12 Niliacus	1.94	0.70	0.68	1.11	1.03
23 Solis	0.35	0.72	0.46	0.51	0.29
41 Titanum	0.93	0.77	0.90	0.87	0.65
50 Elysium N.	0.40	0.52	0.40	0.44	0.28
52 Elysium S.	0.70	0.41	0.56	0.56	0.45
63 Nepenthes	0.67	0.74	0.94	0.78	0.58
74 Syrtis	0.95	0.58	0.62	0.72	0.57
82 Hammonis	0.89	0.77	0.54	0.73	0.52
86 Ismenius	0.98	0.60	0.33	0.64	0.52
89 Edom	1.14	0.68	0.72	0.85	0.67
Mean	±0.88	±0.64	±0.76	±0.76	±0.61

average mean probable error amounts to 0°.76. By it we see that the deviations of the observations of Acidalium and Niliacus are the largest, while those of Elysium North and South and Solis are the smallest recorded. The last column gives the probable error between the two equinoxes. Mean value ±0°.61.

That a seasonal change among the markings occurs, we have had

reason to believe before, as has been stated in several previous Reports, sometimes from changes in their shapes, as when Elysium changed from a pentagon to a circle, sometimes from changes of longitude, as when Lowell twice showed that Aryn had not transitted the central meridian at the computed time. He believed however that the cause was due to an error in the period of rotation, and suggested on different occasions two different periods, one shorter and one longer than the accepted value. We now know however, both from his observations and from those of many others, that the difference was due merely to a shift of Aryn across the surface of the planet. These shifts are usually not extensive, seldom much exceeding 150 miles, or the width of a very wide canal. Thus taking extreme cases, between the vernal and autumnal equinoxes, Hammonis, as is indicated by the black dot in Figure 3, moved $2°.39 \times 2$ or 175 miles to the north, while Solis during the same interval moved 166 miles towards the south. The probable error of our measures between the two equinoxes is as we have just seen $0°.61$, which is equivalent to 22.4 miles measured on the surface of the planet. Taking the average diameter of Mars during these observations to have been about 14″, this would give us 300 miles to 1″ at the center of the disk, therefore the probable error of our measures of this motion based on the drawings is $\pm 0''.075$.

The seventh column of Table II is derived by subtracting the quantities given in the fifth column from those given in the sixth, the eighth column by changing the sign of the quantities in the fifth, and subtracting those in the sixth from them. The seventh column therefore gives the change in latitude from the vernal equinox to the summer solstice, and the eighth the change from the solstice to the autumnal equinox. It will now be seen by comparing these columns that the change in the case of Hammonis occurred fairly uniformly throughout the year, while in the case of Solis it did not really begin until after the summer solstice. Too much stress however must not be laid on the distribution of the change by seasons. As noted in Report **25** and elsewhere, it is believed that extensive changes sometimes occur from night to night, changes which in some cases exceed the average seasonal change. (See also observations made by M. G. Fournier at the observatory of M. Jarry-Desloges. Observations des Surfaces Planetaires, **3**, 249.)

One of the most curious changes occurred in that protean body Elysium. From spring to summer its southern border moved 118 miles to the north, while in the same time its northern border moved 76 miles to the south. After the summer solstice these motions were reversed, southern Elysium moving 18 miles southerly, while northern Elysium moved northerly 86 miles in the same time. From spring to summer its meridional diameter therefore decreased by 194 miles, while it enlarged again by 104 miles in the autumn. It will be noted that Elysium now lies wholly in the northern hemisphere. In our last

Report we showed that it changed its shape materially in 1920. Early in October 1922, corresponding to the middle of the Martian November, it had faded and apparently again shrunk. In December of the same year it was not visible at all. It first appeared in 1913 on November 7, corresponding to the middle of the Martian February, diameter of the planet 10".9. It then extended 0°.5 south of the equator, or some 480 miles south of its mean equinoxial position, and was in contact with the southern maria, which had moved northerly 20° at that time, presumably not by a direct motion, but by a gradual uniform darkening of the intervening desert region. In the Martian October in 1892 it appeared as seen from Arequipa as a small elliptical spot, with a dark center. Although one of the most conspicuous of the northern markings, it was only discovered by Dawes in 1864, and mapped thirteen years later by Proctor. Since it is bounded exclusively by canals, we see how these markings shift over the surface of the planet.

Ismenius is an instance of a shifting lake. It moved 133 miles southerly, chiefly prior to the solstice, carrying with it the two conspicuous canals Protonilus and Deuteronilus, which both lie in an east and west direction. It does not appear therefore that these markings can be bands of vegetation watered by irrigation ditches, as is sometimes supposed. If according to the other theory we imagine that they are merely shower tracks, or perhaps heavy depositions of moisture from fog, the chief objection appears to be that they shift less than we should expect. That they are deposited at night, and every night, if they are deposited at all, and possibly are formed in wide shallow depressed areas as is the case with our fogs, may possibly help to explain their fixity.

But whatever explanation we choose to adopt in this connection is immaterial, the fact appears to be that the canals and other markings do shift about over the surface of the planet to a certain extent. In this respect they resemble the snow caps, but are better situated to locate the axis of the planet, since they cross the disk near its center. Moreover only the northern snow cap, when it is small, during the two and a half to three Martian months about the summer solstice, is really well suited, as we have already seen, for locating the planet's axis. On the other hand we have a dozen dark markings on Mars, suitable for this purpose, most of them visible throughout the whole of the planet's year. We have therefore taken their mean position to locate the axis, regardless of any theory with regard to their origin.

We may mention here however that their apparent shiftings seem to bear some relation to their latitudes, but none to their longitudes. Judged by the fifth and sixth columns of Table II the six stations showing the least motion, arranged in the order of their magnitude, are Niliacus, Syrtis, Nepenthes, Edom, Aromatum, and Titanum. Their mean latitude is 14°. The mean latitude of the seven remaining stations is 26°, thus bearing out the statement made earlier in this

paper that stations in high latitudes shifted the most. The four stations last named lie near the equator, and should be suitable for micrometric measurements. Of the nine remaining stations, Solis was the only one that was not always well situated for observation. At the solstice it lay three-quarters way from the center towards the southern limb.

In the ninth column of Table II an *A* indicates that the direction of motion of the marking was opposite to, or against that of the sun, while a *W* indicates that is was with it. Thus prior to the solstice the motion of Acidalium was against the sun, that is southerly while the sun was moving north. Later when the sun turned south the motion of Acidalium was still southerly. Of the twelve largest shifts of position, each exceeding 2°, four were with the sun, and eight against it. The last column gives the mean latitudes of the thirteen stations at the two equinoxes.

Since the probable error of the three series of measures for any given point averages as we have seen $\pm 0°.76$ or $\pm 45'$, for the whole thirteen stations it would average $\pm 13'$ in the location of the axis. Reducing our corrections to right ascension and declination, we find that the pole is situated in

$$\alpha = 20^h\ 58^m\ 06^s + 1^s.56\ (t - 1918)$$
$$\delta = +\ 52°\ 12'\ 50'' + 12''.6\ (t - 1918).$$

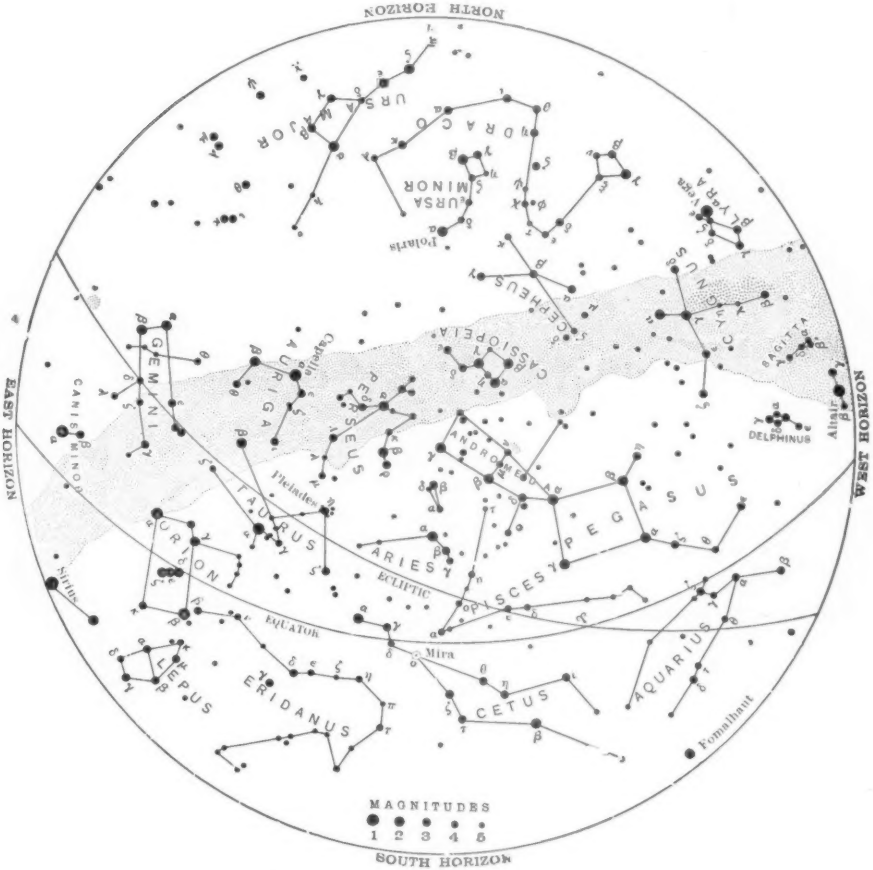
Perhaps the most important effect that this changed position of the pole will have on our observations will be to shift the equinox of the planet back 7°.16 on its orbit from 87°.89 to 80°.73. This will increase each Martian Date by 14 days. Longitudes as well as latitudes will be affected, but the longitudes mainly for markings remote from the equator. As has been above suggested, should these measurements be checked at the coming, or at future apparitions of the planet, the micrometer should be used as well as drawings. For the micrometer, objects whose latitude exceeds 15° are of little value at the solstice which brings them nearest to the limb. Besides the thirteen objects used in this paper several others have been tried, but found unsuitable. Of these the best was Oxia Lacus, which would be an excellent object to add to our list but for the fact that near the vernal equinox we found it to be invisible.

In closing, I cannot omit to mention the very valuable and important aid rendered me by my two assistants, Mr. and Mrs. G. H. Hamilton, without whose help it would have been quite impossible to complete the long series of computations which were involved in the preparation of this paper. The former also measured most of my drawings for me.

Mandeville, Jamaica, June 23, 1923.

PLANET NOTES FOR DECEMBER.

The *sun* will move south until December 22, after which it will begin its motion northward. It will pass from the constellation Scorpio into the constellation Sagittarius.



THE CONSTELLATIONS AT 9:00 P. M. DECEMBER 1.

The phases of the *moon* for this month will occur as follows:

New Moon	December 7 at	8 P.M.	C. S. T.
First Quarter	14 "	9 P.M.	"
Full Moon	23 "	2 A.M.	"
Last Quarter	30 "	3 P.M.	"

The *moon* will be nearest the earth for the month on December 7 and farthest from the earth on December 19.

Mercury at the beginning of the month will be moving eastward faster than the sun, and will set longer after sunset from night to night. It will be at greatest eastern elongation on December 27. On and near this date it will set at practically the same point on the horizon as the sun, and about one hour and a half later than the sun. It should be easily visible to the naked eye in a clear sky.

Venus will be visible throughout the month, but will be quite low in the west at sunset. On December 27 Venus and Mercury will be quite near together and will afford an interesting spectacle on the horizon just after sunset.

Mars will be moving eastward, but less rapidly than the sun during the month. By the end of the month it will rise nearly four hours before the sun, and will be easily seen in the morning sky. It will be coming toward the earth during the month. At the end of the month it will be about 200,000,000 miles away.

Jupiter will again be visible in the east before sunrise. It will not be high enough in the sky for study. At the end of the month is will rise a little more than two hours before the sun. It will be about 21° south of the equator.

Saturn will be visible in the morning. It will be near the meridian and about 9½° south of the equator at sunrise at the end of the month.

Uranus will be in quadrature with the sun, 90° east, on December 9. It will therefore be in the best position possible for evening study.

Neptune will be visible with a telescope in the late evening. At the end of the month it will cross the meridian at $2^h\,40^m$ A. M.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1923	Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N	EMERSION. Washington M.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
Dec. 12	151 B. Capric.	6.1	5 3	49	6 22	264	1 18
15	10 Ceti	6.4	12 16	39	13 7	282	0 51
18	85 Ceti	6.3	11 5	46	12 21	277	1 15
20	179 B. Tauri	5.9	3 49	71	4 48	256	0 59
20	70 Tauri	6.4	15 49	164	16 2	188	0 12
20	75 Tauri	5.2	16 56	53	17 43	300	0 46
21	318 B. Tauri	5.7	4 9	45	4 56	290	0 47
24	*f* Gemin.	5.4	7 25	79	8 25	280	1 0
27	49 Leonis	5.7	19 4	67	19 52	341	0 47
30	46 Virginis	6.1	12 21	137	13 11	263	0 50
30	48 Virginis	6.5	13 55	132	14 56	275	1 1

Ephemeris of Eros (433).

(Continued from page 531.)

Gr. Midnight 1923		α	δ	Log r	Log Δ
		h m s	° ′ ″		
1924 Jan.	1	12 5 13	+ 0 20 44	0.05430	9.63040
	5	12 14 26	— 2 38 12	0.05448	9.62141
	9	12 23 9	— 5 38 18	0.05498	9.61303
	13	12 31 24	— 8 38 47	0.05582	9.60530
	17	12 39 8	—11 38 41	0.05696	9.59813
	21	12 46 24	—14 37 41	0.05836	9.59150
	25	12 53 5	—17 34 17	0.06010	9.58552
	29	12 59 14	—20 28 28	0.06206	9.57994

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1923 December					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8			11 19			
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	4 3	11 18	19 11	27 3		
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	3 13	11 1	18 12	26 0		
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 19	12 22	19 1	25 3		
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	7 13	16 3	24 17			
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	6 9	13 6	20 3	26 23		
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	7 23	15 3	22 8	29 12		
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	8 4	16 23	25 17			
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	1 5	9 4	17 3	25 1		
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6			26 7			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	7 0	15 14	24 5			
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	6 1	12 19	19 14	26 10		
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	6 1	13 22	21 20	29 18		
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	9 11	17 21	26 2			
RV Persei	4 04.2	+33 59	9.5—12.0	1 23.4	6 15	14 12	22 10	30 7		
RW Persei	13.3	+42 04	8.8—11.0	13 04.8		12 14	25 19			
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	7 14	17 0	26 11			
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	6 13	18 23	31 9			
TT Aurigæ	5 02.8	+39 27	7.8— 8.7	0 16.0	5 18	12 10	19 2	25 18		
RY Aurigæ	11.5	+38 13	10.7—11.7	2 17.5	5 21	12 0	20 4	28 8		
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	3 12	9 12	21 13	27 14		
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	8 13	17 5	25 21			
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	10 21	21 7	31 16			
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	4 3	12 4	20 4	28 4		
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	4 14	10 8	21 18	27 12		
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	5 2	11 10	22 15	28 5		
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	6 20	15 0	23 5	31 10		
RW Monoc.	29 3	+ 8 54	9.0—10.8	1 21.7	3 8	10 23	18 14	26 5		
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	2 22	15 3	27 8			
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	5 11	12 15	19 19	26 23		
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	5 13	12 9	19 4	26 0		
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	9 1	18 8	27 15			
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	3 5	9 19	23 1	29 15		
TX Gemin.	30.3	+17 08	10.0—11 9	2 19.2	8 22	17 7	25 17			
RR Puppis	43.5	—41 08	9 4—10.7	6 10.3	6 1	12 11	25 7	31 18		
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	1 8	8 15	23 4	30 10		
X Carinae	8 29 1	—58 53	7.9— 8.7	0 13.0	4 0	12 3	20 5	28 8		
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	9 15	19 3	28 14			
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	1 10	8 7	21 23	28 19		
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	1 9	13 6	19 4	31 1		
Y Leonis	9 31 1	+26 41	9.3—11.2	1 16.5	6 4	12 17	19 16	26 10		
RR Velorum	10 17.8	—41 36	10.0—10 9	1 20.5	8 3	15 13	22 23	30 9		
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	5 3	11 18	24 22	31 13		
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	1 9	10 4	19 0	27 19		
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07 9	4 4	11 13	18 20	26 4		
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	3 5	10 0	23 14	30 9		
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	4 3	11 16	19 3	26 16		
RS Ca i. Ven.	13 06.3	+36 28	7.5—12 5	4 19.1	7 17	17 6	26 21			
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	8 3	15 14	23 1	30 10		
SX Hydræ	13 90.0	—26 23	8.6—12.7	2 21.5	1 19	13 9	19 4	30 18		

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1923 December					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	6 0	12 23	19 23	26 22		
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	1 23	8 21	22 17	29 14		
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.3	4 22	13 8	21 18	30 4		
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	6 0	13 4	20 9	27 13		
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	8 6	15 14	22 22	30 6		
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	5 18	14 1	22 7	30 13		
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	6 10	15 7	24 3			
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	3 0		23 19			
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	6 4	13 0	19 18	26 14		
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	2 12	10 22	19 7	27 16		
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	6 2	12 6	24 13	30 17		
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	6 12	12 17	25 1	31 6		
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	7 10	14 19	22 4	29 13		
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	2 16	10 19	18 23	27 4		
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	2 23	10 12	18 1	25 14		
UX Herculis	49.7	+16 57	8.8—10.5	1 15.2	8 13	16 7	24 1	31 18		
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	5 2	13 2	21 1	29 1		
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	8 19	17 8	25 20			
WY Sagittarii	17 54.9	—23 1	9.5—10.6	4 16.0	5 21	15 5	24 13			
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1		10 20	20 4			
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	6 16	13 22	21 4	28 10		
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	7 8	14 6	21 4	28 2		
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	1 7		16 11			
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	2 15	9 19	24 2	31 6		
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	2 10	9 13	23 18	30 21		
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	1 12	9 19	18 2	26 10		
RR Draconis	40.8	+62 34	9.3—13	2 19.9	7 21	16 9	24 21			
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	1 10	8 1	21 8	28 0		
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8		7 5	20 3			
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	5 9	14 0	20 16	28 7		
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	7 6	14 20	22 10	29 23		
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	2 1	9 6	23 16	30 21		
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	9 12	18 11	27 10			
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	5 19	12 13	19 7	26 1		
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	8 5	15 14	22 23	30 7		
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	2 0	11 12	16 18	27 5		
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	1 6	7 19	20 20	27 9		
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	1 2	13 2	19 2	31 3		
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	5 9	12 1	25 7	31 23		
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	9 13	18 16	27 20			
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	4 21	13 7	21 18	30 4		
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	7 14	14 9	21 4	27 23		
UW Cygni	19.6	+42 55	10.5—13	3 10.8	1 2	8 23	22 18	29 16		
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0			26 11			
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	4 6	13 21	23 11			
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	8 15	17 20	27 1			
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	9 20	18 20	27 19			
WZ Cygni	48.3	+38 27	9.9—10.8	0 14.0	7 9	14 23	22 13	30 4		
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	3 22	14 1	24 3			
RY Aquarii	21 14.8	—11.14	8.8—10.4	1 23.2	7 4	15 1	22 22	30 18		
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	3 19					
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	2 11	12 15	22 18			
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	5 7	15 16	20 21	31 6		
VW Pegasi	51.7	+32 41	10.0—10.6	5 06.4	3 18	14 7	19 14	30 3		
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.3	5 9	12 22	20 11	27 23		
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	8 2	16 8	24 14			

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1923 December							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	9 4							
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	3 13	11 16	19 20	27 23				
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 3	9 21	17 15	25 9				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2		12 22	27 17					
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5 12	13 11	21 9	29 8				
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	1 13	9 8	17 3	24 23				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	8 3		24 12					
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	3 5	11 18	20 8	28 22				
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	8 8	19 11	30 14					
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	2 15	14 7	25 22					
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	4 18	12 10	20 1	27 17				
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	9 15	19 19	29 22					
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	2 23	10 16	18 9	26 3				
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	5 19	11 8	22 9	27 22				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	6 16	13 22	21 12	29 2				
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	6 10							
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	3 5	10 16	18 3	25 14				
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	1 2	9 0	16 22	24 20				
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3 1	13 5	23 9					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5		12 12						
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	5 23	13 21	21 20	27 19				
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	3 4	9 21	23 6	29 23				
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	9 1	18 8	27 14					
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	9 11	18 4	26 22					
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0								
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	7 9	14 4	20 23	27 18				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	2 18	9 8	22 13	29 4				
S Muscae	12 07.4	—69 36	6.4— 7.3	9 15 8	5 3	14 18	24 10					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	2 23	10 23	18 22	26 22				
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	6 0	12 17	19 11	26 4				
R Crucis	18.1	—61 04	6 8— 7.9	5 19.8	4 20	10 16	22 8	28 3				
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	5 12	14 21	19 14	28 23				
W Virginis	13 20 9	— 2 52	8.7—10.4	17 06.5	7 18		26 0					
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	4 10	12 15	20 20	29 0				
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	4 23	12 0	19 0	26 1				
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	3 11	11 16	19 22	28 4				
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	6 21	12 9	23 9	28 21				
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	6 12	14 2	21 15	29 4				
R Triang.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	6 6	12 1	18 19	25 14				
S Triang.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	7 23	14 6	20 14	26 22				
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	3 23	13 17	23 11					
RW Draconis	33.7	+58 03	9.6—10 8	0 10.6	5 1	13 21	22 17	31 14				
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	1 15	13 17	19 19	31 22				
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	2 16	9 16	23 17	30 17				
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	6 11		23 14					
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	3 9	10 23	18 14	26 4				
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	1 2	12 17	18 12	30 1				
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	3 8	10 2	23 2	30 7				
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	2 18	13 3	23 11					
RZ Lyræ	18 39.9	+32 42	9.9—11.2	0 12.3	3 6	9 10	21 16	27 19				
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	6 1	11 23	23 21	29 20				
κ Pavonis	18 46.6	—67 22	3.8— 5 2	9 02.2	3 10	12 12	21 15	30 17				
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	7 12	14 13	21 13	28 14				

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1923 December					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	2 20	9 20	23 20	30 20		
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	6 8	14 7	22 7	30 6		
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	1 8	9 1	16 17	24 9		
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	7 19	15 0	22 4	29 8		
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	6 1	14 10	22 19	31 5		
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	3 19	10 2	22 18	29 2		
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	3 20		20 5			
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4 21	13 18	22 15	31 12		
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	5 7	12 0	18 18	25 11		
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	5 5	11 23	18 16	25 9		
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	8 10		23 3			
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	4 16	12 12	20 18	28 6		
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	6 7	13 5	20 2	26 23		
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	5 12	15 5	20 2	29 19		
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	3 20	12 11	21 3	29 19		
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	5 22	11 7	22 0	27 7		
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	3 16	14 14	25 11			
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	2 0	8 10	21 5	27 15		
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	4 2	14 1	19 0	29 0		
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	3 16	14 13	20 0	30 21		
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	1 3	12 0	17 11	28 8		
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	1 10	7 17	20 7	26 14		
RY Cassiop.	47.2	+58 11	9.3—11 8	12 03.4	8 4		20 7			
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	4 13	11 13	18 12	25 12		

New Variable Star in Vela. — A communication from Miss Harwood reports the discovery at Arequipa in May, 1923, of the variability of the star C.D.—47° 5745. From measurements on thirty-four plates the photographic variation appears to be between magnitudes 9.0 and 10.0. The spectrum is Mb. The position for 1900 is $10^h\,13^m\,31^s$, —47° 27′, and the galactic coordinates are 246°, +8°.

Monthly Report of the American Association of Variable Star Observers, August 20 to September 20, 1923.

This report brings another year's work to a close and the annual report is appended herewith. The only change in the form of this table from previous years is the addition of the approximate aperture in inches of the observer's telescope, given in a column to the right of the totals. The letter "r" indicates reflector.

The following note has been received from the President, Miss Young: Dr. Edison Pettit of Mount Wilson Observatory is studying the radiation of long period variable stars with the vacuum thermocouple, and asks that observations of the following stars be continued as close to the sun as possible, both in morning and evening. Moreover, as his program is so arranged that his observations are made within the period of three days before and after the first quarter of the moon, estimates of magnitudes made on those days are of special value. The stars are: *o* Ceti *021403*, R Leonis Min. 093934, R Leonis 094211, X Ophiuchi 183308, R Lyrae 185243, R Aquilae 190108, R Cygni 193449, RT Cygni 194048, χ Cygni 194632, and R Aquarii *233815*, in addition to α Herculis which is not on our list.

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
001046 X ANDROMEDAE—				
	3644.8	12.9 Wf,	3781.8	11.0 Wf,
	3661.7	11.2 Br,	3773.6	10.3 M.
	3666.7	10.9 Wf,		
001620 T CETI—				
	3640.6	5.8 L,	3652.6	5.8 L,
	3642.6	5.6 An,	3655.6	5.8 An.
	3650.6	5.8 An,		
001726 T ANDROMEDAE—				
	3639.2	10.8 Ch,	3669.7	12.8 Pt.
001755 T CASSIOPEIAE—				
	3640.3	8.8 Pe,	3663.4	7.7 L,
	3642.3	8.6 Pe,	3663.4	7.7 An,
	3642.4	7.9 An,	3663.6	8.2 O,
	3642.4	7.9 L,	3664.6	7.5 Ca,
	3646.3	8.4 Pe,	3669.7	7.8 Pt,
	3648.4	8.3 Pe,	3673.6	8.0 M,
	3653.3	8.3 Pe,	3677.5	7.6 Ca,
	3661.3	8.1 Pe,	3680.6	7.9 O.
001838 R ANDROMEDAE—				
	3644.8	13.8 Wf,	3669.7	13.0 Pt,
	3666.7	14.0 Wf,	3671.7	14.1 Wf,
001868 S TUCANAE—				
	3611.1	9.2 Bl,	3628.0	8.8 Bl.
001909 S CETI—				
	3642.6	13.0 L,	3669.7	13.0 Pt,
	3654.6	12.8 L,	3675.8	11.8 M.
002546 T PHOENICIS—				
	3611.1	9.9 Bl,	3628.0	9.8 Bl.
004047 U CASSIOPEIAE—				
	3640.3	12.2 Pe,	3669.7	13.5 Pt,
	3644.8	12.4 Wf,	3671.7	14.1 Wf,
	3650.8	13.0 Br,	3673.6	9.7 M.
	3666.7	14.0 Wf,		
004132a RW ANDROMEDAE—				
	3644.8	12.6 Wf,	3669.7	10.4 Pt,
	3666.7	10.4 Wf,	3671.7	10.3 Wf.
004435 V ANDROMEDAE—				
	3665.6	9.4 O,	3675.8	9.5 M.
	3673.6	9.7 O,		
004533 RR ANDROMEDAE—				
	3644.8	13.5 Wf,	3671.7	14.6 Wf.
	3668.8	14.8 Wf,		
004746 RV CASSIOPEIAE—				
	3654.6	14.4 L,	3669.7	14.6 Pt.
004958 W CASSIOPEIAE—				
	3650.8	10.8 Br,	3669.7	11.3 Pt.
	3673.6	11.2 Cg,		
005475 U TUCANAE—				
	3611.1	11.1 Bl,	3628.0	11.9 Bl.
010102 Z CETI—				
	3669.7	10.8 Pt.		
010940 U ANDROMEDAE—				
	3644.8	13.1 Wf,	3671.7	13.3 Wf.
	3666.8	13.3 Wf,		
011272 S CASSIOPEIAE—				
	3644.8	7.5 Wf,	3671.6	8.5 M,
	3666.8	8.1 Wf,	3671.7	8.5 Wf.
	3669.7	7.9 Pt,		
011712 U PISCIUM—				
	3669.7	11.4 Pt,	3671.8	10.0 M.
012502 R PISCIUM—				
	3669.8	13.0 Pt.		
013238 RU ANDROMEDAE—				
	3644.8	11.3 Wf,	3669.8	13.4 Pt,
	3666.8	13.0 Wf,	3671.7	13.2 Wf,
013338 Y ANDROMEDAE—				
	3644.2	9.5 Ch,	3669.8	9.5 Pt,
	3644.8	8.8 Wf,	3671.7	9.3 Wf.
	3666.8	9.3 Wf,		
014958 X CASSIOPEIAE—				
	3669.8	10.4 Pt.		
015354 U PERSEI—				
	3648.8	9.8 Sg,	3669.8	9.0 Pt,
	3667.8	9.2 Sg,	3680.6	9.7 Cg.
01591? S ARIETIS—				
	3672.8	14.8 Pt.		
021024 R ARIETIS—				
	3642.6	13.6 L,	3666.8	13.5 Wf,
	3644.8	13.4 Wf,	3671.7	13.2 Wf,
	3647.8	13.5 Wf,	3672.8	12.1 Pt,
	3654.6	12.7 L,	3676.7	8.7 Ca.
021143a W ANDROMEDAE—				
	3644.8	12.0 Wf,	3671.7	11.3 Wf,
	3666.8	11.2 Wf,	3672.8	11.6 Pt.
021258 T PERSEI—				
	3672.8	8.7 Pt.		
021403 o CETI—				
	3642.6	8.2 An,	3654.6	8.6 L,
	3642.6	8.4 L,	3655.6	8.5 An,
	3651.6	8.7 An,	3672.8	8.4 Pt.
021558 S PERSEI—				
	3672.8	9.0 Pt.		
022000 R CETI—				
	3676.7	9.7 Ca.		
022150 RR PERSEI—				
	3644.8	13.8 Wf,	3671.8	13.8 Wf,
	3666.8	14.1 Wf,	3672.8	13.6 Pt.
022813 U CETI—				
	3672.8	9.9 Pt,	3676.7	10.8 Ca.
022980 RR CEPHEI—				
	3644.8	10.8 Wf,	3671.7	10.7 Wf,
	3645.4	10.4 L,	3672.8	11.8 Pt.
	3668.8	11.3 Wf,		
023133 R TRIANGULI—				
	3672.8	8.3 Pt,	3673.8	8.7 M.
024356 W PERSEI—				
	3661.7	8.9 Ca,	3679.6	8.9 O,
	3672.8	9.1 Pt,	3682.6	8.6 Ca.
	3679.6	8.9 O,		
031401 X CETI—				
	3642.6	8.8 An,	3654.6	9.0 L,
	3642.6	9.0 L,	3668.8	9.7 Wf,
	3644.9	8.9 Wf,	3672.8	10.6 Pt.
032043 Y PERSEI—				
	3672.8	8.6 Pt,	3673.8	9.7 M.
032335 R PERSEI—				
	3649.9	13.8 Wf,	3672.8	12.7 Pt.
	3668.8	12.8 Wf,		

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
041619 T TAURI—						
	3671.8	9.8	M.			
042209 R TAURI—						
	3671.8	11.8	M,	3675.8	11.8	Pt.
042215 W TAURI—						
	3671.8	12.2	M,	3675.8	12.3	Pt.
042309 S TAURI—						
	3671.8	11.2	M,	3675.8	13.4	Pt.
043065 T CAMELOPARDALIS—						
	3645.4	8.5	L,	3671.8	9.7	M,
	3663.4	9.1	L,	3675.8	9.1	Pt.
043208 RX TAURI—						
	3675.8	12.0	M,	3675.8	12.6	Pt.
043263 R RETICULAE—						
	3607.9	8.3	Bl,	3619.9	8.4	Bl.
043274 X CAMELOPARDALIS—						
	3644.9	7.9	Wf,	3675.8	8.1	Pt.
	3668.8	8.0	Wf,			
043562 R DORADUS—						
	3607.9	5.0	Bl.			
044617 V TAURI—						
	3649.9	13.3	Wf,	3668.8	12.5	Wf.
045307 R ORIONIS—						
	3676.8	9.5	M.			
045514 R LEPORIS—						
	3652.6	7.9	L,	3678.8	8.5	M.
	3675.8	7.3	Pt,			
050003 V ORIONIS—						
	3675.8	12.1	Pt.			
050022 T LEPORIS—						
	3675.8	11.5	Pt.			
050953 R AURIGAE—						
	3644.9	13.5	Wf,	3675.8	12.9	Pt.
	3668.8	13.0	Wf,			
052034 S AURIGAE—						
	3640.6	9.7	L,	3675.8	8.6	Pt,
	3652.6	9.8	L,	3675.8	9.8	M.
052036 W AURIGAE—						
	3640.6	12.7	L,	3675.8	9.2	Pt.
	3652.6	12.0	L,			
052404 S ORIONIS—						
	3671.8	11.0	M,	3680.8	11.0	Ca.
	3675.8	10.5	Pt,			
052005a T ORIONIS—						
	3652.6	11.3	L,	3675.8	9.8	Pt,
	3671.8	10.7	M,	3678.8	9.7	Pt.
	3672.8	10.1	Pt,			
053068 S CAMELOPARDALIS—						
	3671.8	8.6	M,	3675.8	8.5	Pt.
053531 U AURIGAE—						
	3671.8	10.5	M,	3675.8	10.2	Pt.
054319 SU TAURI—						
	3640.6	9.3	L,	3668.8	9.4	Wf,
	3642.6	9.4	L,	3669.8	9.5	Pt,
	3642.6	9.3	An,	3670.9	9.4	Wf,
	3644.9	9.4	Wf,	3671.8	9.5	M,
	3649.9	9.4	Wf,	3672.8	9.6	Pt,
	3652.6	9.3	L,	3675.8	9.5	Pt,
	3654.6	9.5	L,	3676.8	9.5	Pt,
	3660.9	9.5	Pt,	3678.8	9.5	Pt.
054615a Z TAURI—						
	3649.9	10.5	Wf,	3668.9	11.9	Wf.
054615c RU TAURI—						
	3649.9	10.5	Wf,	3668.9	12.8	Wf.
054920a U ORIONIS—						
	3668.7	6.8	Ca,	3675.8	6.5	Pt.
	3671.8	7.5	M,			
054974 V CAMELOPARDALIS—						
	3644.9	13.7	Wf,	3670.9	14.0	Wf.
	3666.7	13.8	Wf,			
055353 Z AURIGAE—						
	3644.9	10.6	Wf,	3671.8	10.4	M,
	3668.8	10.4	Wf,	3675.8	10.0	Pt.
055686 R OCTANTIS—						
	3607.9	12.0	Bl,	3619.9	11.7	Bl.
060450 X AURIGAE—						
	3675.8	12.5	Pt.			
060547 SS AURIGAE—						
	3572.6	[12.6	L.	3670.9	[14.5	Wf,
	3573.3	[12.4	L,	3671.8	[13.9	Wf,
	3640.6	[13.0	L,	3671.8	[12.4	M,
	3644.9	[13.7	Wf,	3672.7	[13.9	Wf,
	3647.8	[13.9	Wf,	3672.8	[12.6	Pt,
	3648.8	[13.9	Wf,	3673.7	[12.6	Pt.
	3649.8	[13.9	Wf,	3673.7	14.9	Wf,
	3652.6	[13.0	L,	3675.8	11.2	M,
	3654.6	[14.5	L,	3675.8	11.0	Pt,
	3660.9	[12.4	Pt,	3676.6	10.8	Pt,
	3661.7	[12.4	Wf,	3676.8	10.9	M,
	3672.7	[13.0	Wf,	3677.8	10.6	M,
	3666.7	[13.9	Wf,	3678.8	10.8	M,
	3668.7	[11.5	Pt,	3678.8	10.7	Pt,
	3668.8	[14.5	Wf,	3679.7	10.8	Pt,
	3669.7	[14.5	Wf,	3679.8	11.0	M,
	3669.8	[12.6	Pt,			
061702 V MONOCEROTIS—						
	3675.8	11.8	Pt.			
063308 R MONOCEROTIS—						
	3675.8	10.6	Pt.			
063558 S LYNCIS—						
	3675.8	13.4	Pt.			
064707 W MONOCEROTIS—						
	3675.8	10.6	Pt.			
065355 R LYNCIS—						
	3644.9	8.7	Wf,	3675.8	9.4	Pt.
	3668.8	9.8	Wf,			
070109 V CANIS MINORIS—						
	3670.9	9.2	Wf.			
070122a R GEMINORUM—						
	3668.9	11.8	Wf,	3675.9	11.5	Pt.
	3670.9	11.6	Wf,			
070122b Z GEMINORUM—						
	3675.9	12.6	Pt.			
070122c TW GEMINORUM—						
	3676.8	8.1	Ca.			
070310 R CANIS MINORIS—						
	3652.6	11.3	L.			
071713 V GEMINORIUM—						
	3675.9	10.1	Pt.			
072708 S CANIS MINORIS—						
	3653.6	10.5	L,	3675.9	11.4	Pt.

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
072811 T CANIS MINORIS—						
	3670.9	11.2	Wf,	3675.9	11.2	Pt.
073508 U CANIS MINORIS—						
	3675.9	11.3	Pt.			
073723 S GEMINORUM—						
	3675.9	9.2	Pt.			
074241 W PUPPIS—						
	3607.9	10.3	Bl,	3619.9	9.2	Bl.
074922 U GEMINORUM—						
	3652.6	[13.2	L,	3672.8	[13.3	Pt,
	3670.9	[14.0	Wf.	3675.9	[13.3	Pt.
081112 R CANCRI—						
	3675.9	10.8	Pt.			
081617 V CANCRI—						
	3675.9	9.1	Pt.			
082476 R CHAMAELEON.—						
	3607.9	9.2	Bl,	3626.9	8.6	Bl.
	3619.9	8.8	Bl.			
084803 S HYDRAE—						
	3675.9	8.6	Pt.			
085120 T CANCRI—						
	3675.8	8.2	Pt.			
091868 RW CARINAE—						
	3607.9	11.4	Bl,	3626.9	10.0	Bl.
	3619.9	10.8	Bl.			
092551 Y VELORUM—						
	3607.9	12.3	Bl.			
092962 R CARINAE—						
	3607.9	8.7	Bl,	3629.9	8.9	Bl.
	3619.9	9.1	Bl,			
093178 Y DRACONIS—						
	3634.5	9.3	Gd.			
094953 Z VELORUM—						
	3607.9	13.0	Bl.			
100661 S CARINAE—						
	3607.9	6.4	Bl,	3626.9	7.3	Bl.
	3619.9	8.8	Bl.			
101058 Z CARINAE—						
	3607.9	12.7	Bl,	3619.9	12.5	Bl.
101153 W VELORUM—						
	3607.9	11.5	Bl,	3626.9	10.7	Bl.
	3619.9	10.9	Bl,			
103769 R URSAE MAJORIS—						
	3638.6	9.8	Kl,	3656.6	10.5	Kl,
	3641.7	9.8	Kl,	3661.6	10.8	Kl,
	3643.1	9.6	Ch,	3661.7	10.5	Wf,
	3644.6	9.8	Kl,	3666.7	10.3	Br,
	3644.7	10.0	Wf,	3667.6	11.5	Fe,
	3646.6	10.5	Kl,	3669.7	11.0	Wf,
	3649.6	10.6	Kl,	3673.6	11.4	Pt,
	3651.6	10.5	Kl,	3673.6	10.3	M,
	3653.6	10.3	Kl,	3675.6	11.7	Fe.
104620 V HYDRAE—						
	3607.9	9.4	Bl,	3626.8	8.8	Bl.
	3619.9	8.5	Bl.			
104628 RS HYDRAE—						
	3607.9	12.0	Bl,	3626.9	10.5	Bl.
	3619.9	10.9	Bl.			
111561 RY CARINAE—						
	3607.9	11.8	Bl,	3626.9	10.8	Bl.
	3619.9	10.8	Bl.			
111661 RS CENTAURI—						
	3607.9	12.1	Bl,	3619.9	12.3	Bl.
115058 W CENTAURI—						
	3608.9	10.6	Bl,	3626.9	9.2	Bl.
	3620.9	9.3	Bl.			
122532 T CANUM VENATICORUM—						
	3660.6	10.5	Pt.			
122854 U CENTAURI—						
	3608.9	10.5	Bl,	3626.9	9.1	Bl.
	3620.0	10.3	Bl.			
123160 T URSAE MAJORIS—						
	3637.4	10.1	Pe,	3651.6	11.2	Kl,
	3638.6	10.8	Kl,	3653.6	11.0	Kl.
	3640.3	10.5	Pe,	3656.6	11.3	Kl,
	3640.6	9.8	Bw,	3661.6	11.5	Kl,
	3641.3	11.0	Pe,	3661.7	11.6	Wf,
	3644.6	10.4	Kl,	3666.7	12.2	Br,
	3644.7	10.4	Wf,	3669.7	12.2	Wf,
	3646.3	11.5	Pe,	3673.6	12.3	Pt,
	3646.6	11.0	Kl,	3675.6	12.4	Fe.
	3649.6	11.1	Kl,			
123459 RS URSAE MAJORIS—						
	3644.7	13.3	Wf,	3666.7	12.4	Br,
	3661.7	12.4	Wf,	3669.7	11.8	Wf,
	3665.6	12.4	M,	3673.6	11.8	Pt.
123961 S URSAE MAJORIS—						
	3641.3	9.6	Pe,	3661.7	10.2	Wf,
	3642.4	9.6	An,	3663.3	10.6	An.
	3644.7	9.4	Wf,	3663.3	10.9	L,
	3645.4	10.0	L,	3666.7	10.7	Br,
	3646.3	9.2	Pe,	3669.7	10.6	Wf,
	3653.3	9.4	Pe,	3673.6	11.5	Pt.
	3660.7	10.9	Sg,			
131283 U OCTANTIS—						
	3608.9	12.7	Bl,	3626.9	11.6	Bl.
	3620.0	12.3	Bl,			
132422 R HYDRAE—						
	3608.9	8.7	Bl,	3626.9	8.3	Bl.
	3620.0	8.7	Bl.			
133155 RV CENTAURI—						
	3608.9	7.5	Bl,	3626.9	7.2	Bl.
	3620.0	7.5	Bl,			
133273 T URSAE MINORIS—						
	3644.7	11.4	Wf,	3666.7	12.2	Br,
	3661.7	12.1	Wf,	3669.7	12.3	Wf.
133633 T CENTAURI—						
	3608.9	6.3	Bl,	3626.9	7.6	Bl.
	3620.0	6.6	Bl,			
134236 RT CENTAURI—						
	3608.9	12.1	Bl,	3626.9	10.0	Bl.
	3620.0	10.5	Bl,			
134440 R CANUM VEN.—						
	3638.6	12.0	Kl,	3669.6	12.1	Pt.
134677 T APODIS—						
	3608.9	8.8	Bl,	3626.9	8.8	Bl.
	3620.0	8.9	Bl.			
140113 Z BOOTIS—						
	3644.7	10.6	Wf,	3670.6	9.6	Wf,
	3661.7	9.8	Wf,	3674.6	9.7	O.
140528 RU HYDRAE—						
	3608.9	10.6	Bl,	3626.9	10.8	Bl.
	3620.0	11.1	Bl,			
140959 R CENTAURI—						
	3608.9	8.3	Bl,	3626.9	8.3	Bl.
	3620.0	8.0	Bl.			

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
141567 U URSAE MINORIS—						
	3642.1	11.6	Ch,	3667.6	12.5	Fe,
	3665.6	13.0	Fe,	3669.6	12.4	Pt.
	3666.7	12.5	Br,			
141954 S BOOTIS—						
	3636.4	12.4	L,	3661 7	13.0	Wf,
	3644.7	12.8	Wf,	3669.6	13.5	Pt,
	3648.4	12.6	L,	3669.7	13.3	Wf.
142539 V BOOTIS—						
	3636.4	7.9	L,	3666.6	7.8	Cy,
	3648.4	7.9	L,	3667.6	8.0	O,
	3648.4	8.5	Pe,	3667.7	7.0	Sg,
	3648.8	7.8	Sg,	3669.6	7.3	Pt,
	3659.5	7.8	Ca,	3673.6	7.3	Fe,
	3661.3	8.1	Pe,	3682.5	7.3	Ca.
	3662.6	7.8	Fe,			
142584 R CAMELOPARDALIS—						
	3644.7	12.8	Wf,	3669.7	10.5	Wf,
	3661.7	11.2	Wf,	3674.7	10.2	Ca.
	3666.7	10.6	Br,			
143227 R BOOTIS—						
	3645.4	10.6	Pe,	3667.6	8.7	O,
	3648.4	8.5	Pe,	3668.7	9.4	Sg,
	3662.6	9.2	Ca,	3669.6	8.6	Pt,
	3662.6	9.0	O,	3673.5	8.3	M,
145254 Y LUPI—						
	3608.9	12.6	Bl.			
145971 S APODIS—						
	3608.9	9.9	Bl,	3626.9	9.8	Bl.
	3620.1	9.4	Bl,			
150018 RT LIBRAE—						
	3669.6	10.0	Pt.			
150605 Y LIBRAE—						
	3636.4	9.2	L,	3669.6	9.5	Pt.
	3648.4	8.8	L,			
151520 S LIBRAE—						
	3635.4	11.3	L.	3639.1	10.8	Ch.
151714 S SERPENTIS—						
	3642.4	8.3	An,	3662.5	8.3	Ca,
	3642.4	8.3	L,	3669.6	8.3	Pt,
	3644.7	8.6	Wf,	3670.6	8.5	Wf,
	3661.7	8.4	Wf,	3673.6	8.7	O,
	3662.3	8.3	L,	3674.5	8.6	Ca.
151731 S CORONAE BOREALIS—						
	3644.7	11.9	Wf,	3669.6	11.9	Pt,
	3661.7	12.0	Wf,	3669.7	11.6	Wf.
151822 RS LIBRAE—						
	3608.9	7.5	Bl,	3638.3	8.1	L,
	3620.1	7.4	Bl,	3648.3	8.5	L.
	3626.9	7.3	Bl,			
152714 RU LIBRAE—						
	3638.4	12.5	L,	3669.6	13.0	Pt.
	3648.3	12.9	L.			
152849 R NORMAE—						
	3608.9	13.0	Bl.			
153220 X LIBRAE—						
	3608.9	13.0	Bl,	3620.1	12.4	Bl.
153378 S URSAE MINORIS—						
	3644.7	10.2	Wf,	3669.7	10.4	Wf,
	3648.8	9.7	Sg,	3672.5	10.6	Ro,
	3661.7	10.2	Wf,	3673.5	10.6	Ro,
	3662.5	10.5	Ro,	3673.7	10.6	Cy,
	3667.8	11.0	Sg,	3673.7	11.2	Cv,
	3669.6	10.0	Pt,	3674.7	10.4	Ca.
154428 R CORONAE BOREALIS—						
	3611.3	7.1	Pe,	3662.6	6.8	O,
	3612.3	7.1	Pe,	3662.6	6.2	Cv,
	3615.3	7.0	Pe,	3662.6	6.2	Cy,
	3626.6	6.5	Cg,	3662.7	6.4	Wf,
	3633.1	6.1	Ch,	3663.3	6.2	L,
	3635.4	6.1	L,	3663.3	6.2	An,
	3636.4	6.2	L,	3663.6	6.3	O,
	3634.4	6.3	L,	3664.6	6.4	Ca,
	3637.4	6.1	Pe,	3665.6	6.2	O,
	3638.4	6.3	L,	3666.6	6.2	Pt,
	3638.4	6.1	Pe,	3666.7	6.3	Wf,
	3638.7	6.5	Kl,	3667.5	6.3	Ya,
	3639.1	6.1	Ch,	3667.6	6.3	Ca,
	3639.4	6.3	L,	3667.6	6.4	Fe,
	3640.3	6.1	Pe,	3668.6	6.3	Ca,
	3641.7	6.7	Kl,	3668.6	6.2	Pt,
	3642.4	6.2	An,	3668.7	6.8	Sg,
	3642.4	6.2	L,	3669.6	6.5	O,
	3644.7	6.4	Wf,	3669.6	6.6	Mh
	3644.7	6.7	Kl,	3669.6	6.3	Pt,
	3645.3	6.2	L,	3669.7	6.4	Wf,
	3645.4	6.1	Pe,	3671.7	6.5	Wf,
	3646.4	6.1	An,	3672.6	6.3	Pt,
	3646.7	6.7	Kl,	3672.6	6.2	Fe,
	3647.7	6.3	Wf,	3672.7	6.6	Wf,
	3648.4	6.3	L,	3673.6	6.2	Pt.
	3648.8	6.3	Wf,	3673.6	6.2	O,
	3649.4	6.2	L,	3673.6	6.3	Cg,
	3649.6	6.7	Kl,	3673.6	6.0	M,
	3649.8	6.5	Wf,	3673.7	6.5	Cv,
	3651.3	6.2	L,	3673.7	6.5	Cy,
	3651.6	6.7	Kl,	3673.7	6.4	Wf,
	3652.6	6.3	Pt,	3674.6	6.6	O,
	3653.6	6.8	Kl,	3674.6	6.3	Ca,
	3654.6	6.3	Pt,	3675.5	6.0	O,
	3655.7	6.2	Sg,	3675.6	6.1	Fe,
	3656.6	6.8	Kl,	3675.6	6.3	Pt,
	3656.6	6.2	Pt,	3676.6	6.2	Pt,
	3656.7	6.8	Bw,	3676.6	6.4	Ca,
	3658.7	6.0	Sg,	3677.7	6.5	Cg,
	3660.6	5.9	O,	3677.6	6.2	Pt,
	3660.6	6.3	Pt,	3680.6	6.3	Ca,
	3661.3	6.2	Pe,	3680.6	6.3	Cg,
	3661.3	6.4	L,	3680.6	6.1	Cd,
	3661.6	6.8	Kl,	3680.6	6.0	O,
	3662.3	6.3	L,	3680.6	6.2	O,
	3662.5	6.3	Ca,	3682.5	6.4	Ca.
154536 X CORONAE BOREALIS—						
	3669.6	8.8	Pt.			
154615 R SERPENTIS—						
	3640.3	11.8	Pe,	3669.6	12.7	Pt.

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
154639 V CORONAE BOREALIS—						
	3644.7	9.1	Wf,	3669.6	7.2	Pt,
	3651.6	9.0	M,	3673.6	8.7	O,
	3662.7	8.5	Wf,	3677.6	7.0	Ca,
	3664.6	7.7	Ca,	3690.6	8.2	Wf.
155823 RZ SCORPII—						
	3669.6	9.6	Pt.			
160021 Z SCORPII—						
	3610.9	12.0	Bl,	3638.4	11.8	L,
	3620.1	12.1	Bl,	3648.4	11.4	L,
	3626.9	11.2	Bl,			
160210 U SERPENTIS—						
	3669.6	13.6	Pt.			
160625a RU HERCULIS—						
	3638.4	11.1	L,	3662.7	12.2	Wf,
	3644.7	11.5	Wf,	3669.6	12.5	Pt,
	3649.4	11.8	L,	3670.6	12.1	Wf.
160625b SX HERCULIS—						
	3638.4	7.9	L,	3661.7	8.7	Wf,
	3644.7	8.4	Wf,	3666.6	8.7	Pt,
	3647.7	8.4	Wf,	3669.6	9.0	Pt,
	3649.4	8.2	L,	3670.6	9.4	Wf,
	3652.6	8.2	Pt,	3672.6	8.8	Pt,
	3656.6	8.4	Pt,	3675.6	9.0	Pt.
	3660.6	8.5	Pt,			
*161122*a R SCORPII—						
	3669.6	11.0	Pt.			
*161122*b S SCORPII—						
	3669.6	10.8	Pt.			
161138 W CORONAE BOREALIS—						
	3644.7	9.9	Wf,	3674.6	7.5	Ya,
	3662.7	8.3	Wf,	3676.6	7.9	Cd,
	3667.6	7.8	Sg,	3673.6	8.3	O,
	3669.6	7.4	Pt,	3677.6	7.6	Sg,
	3670.6	7.8	Wf,			
161607 W OPHIUCHI—						
	3642.4	14.0	L,	3669.6	13.5	Pt.
162112 V OPHIUCHI—						
	3667.5	8.3	Sg,	3669.6	8.5	Pt.
162119 U HERCULIS—						
	3638.4	10.8	Pe,	3662.7	11.4	Wf,
	3638.7	11.2	Sg,	3667.6	11.5	Sg,
	3640.3	11.2	Pe,	3667.7	11.5	Sg,
	3644.7	11.3	Wf,	3669.6	11.1	Pt,
	3648.8	11.5	Sg,	3670.6	11.6	Wf.
162319 Y SCORPII—						
	3639.4	11.4	L,	3648.4	11.3	L.
162807 SS HERCULIS—						
	3642.4	8.9	L,	3663.3	10.4	L.
	3642.4	8.9	An,	3669.6	11.2	Pt.
	3663.3	10.4	An,			
162815 T OPHIUCHI—						
	3610.9	13.0	Bl,	3642.4	13.4	L.
162816 S OPHIUCHI—						
	3611.0	10.5	Bl,	3639.4	12.8	L.
	3620.1	11.8	Bl,			
163137 W HERCULIS—						
	3669.6	12.5	Pt,	3674.6	11.7	Ya.
163266 R DRACONIS—						
	3638.2	7.5	Ch,	3669.6	7.9	Pt,
	3662.6	7.7	O,	3674.7	8.3	Sg.
	3663.7	7.9	Sg,			
164319 RR OPHIUCHI—						
	3639.4	10.8	L,	3669.6	12.3	Pt.
	3651.4	11.3	L,			
164715 S HERCULIS—						
	3661.7	7.4	Sg,	3669.6	7.9	Pt,
	3667.6	7.3	Sg,	3682.5	7.2	Sg.
164844 RS SCORPII—						
	3611.0	6.7	Bl,	3627.0	7.0	Bl.
	3620.1	6.7	Bl,			
165030 RR SCORPII—						
	3611.0	7.6	Bl,	3627.0	7.0	Bl.
	3620.1	7.5	Bl,			
165202 SS OPHIUCHI—						
	3669.7	11.6	Pt.			
165631 RV HERCULIS—						
	3669.7	13.9	Pt,	3679.6	14.2	M.
165636 RT SCORPII—						
	3611.0	8.9	Bl,	3627.0	10.3	Bl.
	3620.1	9.7	Bl,			
170215 R OPHIUCHI—						
	3638.7	9.2	Kl,	3656.6	7.9	Kl,
	3639.1	9.3	Gd,	3661.6	7.8	Kl,
	3644.7	9.2	Kl,	3663.5	7.3	Sg,
	3645.4	9.4	Pe,	3665.7	7.5	Sg,
	3646.3	9.4	Pe,	3667.5	7.1	Sg,
	3646.7	9.2	Kl,	3669.6	8.4	Fe,
	3649.6	8.8	Kl,	3669.7	7.2	Pt,
	3651.6	8.5	Kl,	3674.5	7.3	Sg,
	3653.6	8.4	Kl,	3677.5	7.3	Sg,
	3655.7	8.2	Gd,			
170627 RT HERCULIS—						
	3644.7	10.2	Wf,	3669.7	10.7	Pt.
	3662.7	10.6	Wf,	3670.6	10.5	Wf,
170833 RW SCORPII—						
	3611.0	12.6	Bl.			
171401 Z OPHIUCHI—						
	3669.7	11.6	Pt.			
171723 RS HERCULIS—						
	3644.7	8.1	Wf,	3669.7	9.6	Pt,
	3662.7	8.8	Wf,	3670.6	9.4	Wf.
172486 S OCTANTIS—						
	3611.0	9.7	Bl,	3628.0	8.8	Bl.
	3620.1	8.3	Bl,			
172809 RU OPHIUCHI—						
	3651.6	10.0	M.	3669.7	10.7	Pt.
173212 RT SERPENTIS—						
	3645.4	9.3	L,	3661.3	9.4	L.
173543 RV SCORPII—						
	3611.0	11.3	Bl,	3627.0	10.8	Bl.
	3621.9	10.8	Bl.			
174162 W PAVONIS—						
	3611.0	12.8	Bl.			
174406 RS OPHIUCHI—						
	3669.7	11.1	Pt.			
175458a T DRACONIS—						
	3665.6	11.6	M.			

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
175458b UY DRACONIS—						
	3665.6	11.0	M.			
175519 RY HERCULIS—						
	3669.7	14.0	Pt.			
175654 V DRACONIS						
	3669.7	12.9	Pt.			
180531 T HERCULIS—						
	3638.4	11.9	L,	3669.7	8.9	Mh,
	3644.7	11.2	Wf,	3669.7	8.6	Pt,
	3647.7	10.9	Wf,	3670.7	9.2	Wf,
	3649.4	10.3	L,	3672.6	8.8	Cd,
	3661.7	9.1	Wf,	3673.6	8.8	O,
	3661.7	8.9	Sg,	3679.6	8.6	M,
	3667.8	9.0	Sg,	3680.6	8.4	Sg.
180565 W DRACONIS—						
	3669.7	14.8	Pt.			
180911 NOVA OPHIUCHI #4—						
	3669.7	13.6	Pt.			
181031 TV HERCULIS—						
	3638.4	9.5	L,	3649.4	9.7	L.
181103 RY OPHIUCHI—						
	3644.7	12.8	Wf,	3669.7	9.3	Pt,
	3647.7	12.1	Wf,	3670.7	9.4	Wf.
	3661.7	10.3	Wf,			
181136 W LYRAE—						
	3644.7	8.6	Wf,	3669.7	8.1	Pt,
	3645.4	8.4	L,	3670.7	8.4	Wf,
	3647.4	8.4	Wf,	3671.8	8.4	Ct,
	3661.7	8.4	Wf,	3676.6	8.2	O,
	3662.8	8.3	Sg,	3680.6	8.7	Sg,
	3663.3	8.2	O,	3680.7	8.6	Ct.
	3663.7	8.5	Sg.			
182133 RV SAGITTARII—						
	3611.0	8.1	Bl,	3627.0	9.5	Bl.
	3620.1	9.0	Bl,			
182224 SV HERCULIS—						
	3638.4	12.9	L,	3649.4	12.5	L.
183308 X OPHIUCHI—						
	3639.4	8.7	L,	3669.7	8.2	Pt,
	3651.3	8.6	L,	3673.6	8.6	Fe,
	3662.6	8.5	Fe,	3673.7	8.9	Cy,
	3663.6	8.9	O,	3673.7	9.2	Cv.
184134 RY LYRAE—						
	3679.6	14.5	M.			
184205 R SCUTI—						
	3633.4	5.7	An,	3662.6	5.8	O,
	3636.4	5.7	An,	3663.3	5.6	An,
	3637.4	5.8	Pe,	3664.6	5.3	Sg,
	3638.6	5.6	Kl,	3665.6	5.5	Em
	3641.4	5.4	An,	3666.6	5.8	Cy,
	3641.7	5.5	Kl,	3666.6	6.0	Pt,
	3642.4	5.2	L,	3667.6	5.6	Ly,
	3642.4	5.5	An,	3667.6	5.6	Sg,
	3643.7	5.5	Gd,	3668.6	5.6	Sg.
	3644.3	5.7	Pe,	3668.6	5.9	Pt,
	3644.4	5.7	Pe,	3668.7	5.2	Sg,
	3644.7	5.6	Kl,	3669.6	5.9	Pt,
	3646.4	5.5	An,	3669.6	6.0	Mh,
	3646.6	5.7	Kl,	3671.8	5.5	Ct,
	3649.6	5.6	Kl,	3672.5	5.6	Ro,
	3649.8	5.5	Sg,	3672.6	5.8	Pt,
184205 R SCUTI—*Continued.*						
	3650.4	5.5	An,	3673.5	5.7	Ro,
	3651.6	5.8	Kl,	3673.6	5.8	Pt,
	3652.6	5.5	Pt,	3673.6	6.2	Cy,
	3653.6	5.8	Kl,	3673.6	6.0	Cv,
	3654.6	5.0	Pt,	3673.6	6.0	Ly,
	3658.5	5.1	Pt,	3674.6	5.6	Sg,
	3656.6	4.9	Pt,	3674.6	5.5	Ya,
	3656.6	5.7	Kl,	3674.6	5.6	Cd,
	3659.6	5.4	Sg,	3675.6	5.9	Pt.
	3660.6	5.4	Pt,	3676.6	5.6	Pt.
	3660.6	5.5	Ly,	3677.6	5.7	Pt,
	3660.7	5.2	Sg,	3677.6	5.7	Sg.
	3661.3	5.2	L,	3679.5	5.7	Ro.
	3661.6	5.5	Pt,	3679.7	5.7	Pt,
	3661.6	5.7	Kl,	3680.6	5.7	Sg.
	3662.3	5.6	An,	3680.6	5.7	Ly.
	3662.5	5.6	Ro,	3680.7	5.5	Ct,
	3662.5	5.1	Sg,	3682.5	5.7	Sg.
	3662.6	5.5	Cy,	3684.7	5.4	Ct.
	3662.6	5.7	Cv.			
184243 RW LYRAE—						
	3669.7	13.9	Pt.			
184300 NOVA AQUILAE #3—						
	3640.6	10.3	L,	3665.6	9.9	Em,
	3643.1	10.3	Ch,	3666.6	10.3	Pt.
	3656.6	10.1	Pt,	3672.5	10.5	Ro,
	3660.7	10.4	Sg,	3673.5	10.5	Ro,
	3661.3	10.3	L,	3675.6	10.1	Pt.
	3662.5	10.5	Ro,	3679.5	10.4	Ro.
	3664.6	10.4	Sg,			
185437 S CRUCIS AUS.—						
	3611.0	11.2	Bl,	3620.1	11.9	Bl.
185437a R CRUCIS AUS.—						
	3611.0	12.8	Bl,	3620.1	13.3	Bl.
185437b T CRUCIS AUS.—						
	3620.1	13.8	Bl.			
185634 Z LYRAE—						
	3645.4	12.1	L,	3669.7	12.8	Pt.
190108 R AQUILAE—						
	3644.1	9.0	Ch,	3674.6	10.0	Sg.
	3669.7	9.8	Pt.			
190529a V LYRAE—						
	3669.7	13.1	Pt.			
190819a RW SAGITTARII—						
	3641.1	9.5	Ch,	3673.7	9.5	Pt.
190907 TY AQUILAE—						
	3669.7	10.5	Pt.			
190925 S LYRAE—						
	3639.1	12.4	Ch,	3639.7	13.0	Pt,
	3645.4	12.0	L,	3679.6	12.6	M.
190926 X LYRAE—						
	3669.7	9.0	Pt.			
190933a RS LYRAE—						
	3641.1	10.2	Ch,	3669.7	11.4	Pt.
	3664.7	11.0	Br,			
190967 U DRACONIS—						
	3641.1	12.4	Ch,	3669.7	11.4	Pt.
	3664.7	11.9	Pr,			

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
191017 T SAGITTARII—						
	3642.1	9.4	Ch,	3673.6	10.4	Pt.
191019 R SAGITTARII—						
	3665.7	10.6	Sg,	3669.7	11.2	Pt.
	3666.7	11.5	Br.			
191033 RY SAGITTARII—						
	3620.1	9.3	Bl,	3651.4	11.5	L,
	3621.9	9.1	Bl,	3654.6	[9.0	Pt,
	3628.0	9.1	Bl,	3656.6	[9.0	Pt,
	3633.1	9.5	Ch,	3660.6	12.1	Pt,
	3634.4	10.6	L,	3661.3	9.6	L,
	3636.4	11.0	L,	3666.6	[10.0	Pt,
	3638.4	10.4	L,	3669.6	10.4	Pt,
	3639.2	10.5	Ch,	3672.6	11.7	Pt,
	3639.4	10.9	L,	3673.6	11.3	Pt.
	3642.4	12.0	L,	3675.6	11.4	Pt,
	3642.4	11.9	An,	3676.6	11.5	Pt.
	3649.4	12.0	L,	3677.6	11.7	Pt.
191319 S SAGITTARII—						
	3611.0	10.4	Bl,	3628.0	10.6	Bl,
	3620.1	10.6	Bl,	3669.7	12.7	Pt.
191331 SW SAGITTARII—						
	3611.0	10.6	Bl,	3628.0	10.1	Bl.
	3620.1	10.3	Bl,			
191637 U LYRAE—						
	3669.7	11.1	Pt.			
192928 TY CYGNI						
	3669.7	11.0	Pt.			
193311 RT AQUILAE—						
	3633.1	10.0	Ch,	3669.7	11.1	Pt.
193449 R CYGNI—						
	3633.1	7.6	Ch,	3666.5	9.0	Cy,
	3639.1	7.6	Ch,	3667.7	8.6	Sg,
	3644.7	7.1	Wf,	3668.7	8.8	Pt,
	3655.2	8.2	Ch,	3670.8	9.5	Wf,
	3659.5	8.3	Sg,	3673.7	9.0	Cy,
	3662.7	8.6	Wf,	3673.7	9.6	Cv,
	3664.7	9.3	Br,	3680.7	8.8	Sg.
193509 RV AQUILAE—						
	3640.7	12.1	Br,	3668.7	12.6	Pt.
	3664.8	12.4	Br.			
193972 T PAVONIS—						
	3611.0	10.4	Bl,	3628.0	11.7	Bl,
	3621.9	11.5	Bl.			
194048 RT CYGNI—						
	3633.1	8.9	Ch,	3668.7	7.5	Pt,
	3639.1	8.1	Ch,	3668.7	7.7	Sg,
	3655.2	7.5	Ch,	3680.6	8.0	Pi,
	3664.7	7.5	Br,	3680.7	8.0	Sg,
	3667.7	7.5	Sg.			
194348 TU CYGNI—						
	3639.1	11.6	Ch,	3668.7	9.4	Pt,
	3664.7	10.0	Br,	3680.6	8.5	Pt.
194604 X AQUILAE—						
	3647.7	14.4	Wf,	3666.7	14.5	Wf,
	3665.6	14.0	M.	3672.6	14.8	Pt.
194632 χ CYGNI—						
	3633.1	9.4	Ch,	3671.8	7.7	Ct,
	3645.4	8.5	Pe,	3674.7	7.7	Sg,
	3648.4	8.4	Pe,	3676.7	7.8	O,
	3648.7	8.2	Br,	3680.7	7.3	Sg,
	3660.6	7.7	Pt,	3680.7	7.2	Ct,
	3661.5	8.0	Sg,	3684.7	6.8	Ct.
	3668.7	7.8	Sg,			
194929 RR SAGITTARII—						
	3611.0	13.0	Bl.			
195142 RV SAGITTARII—						
	3611.0	10.7	Bl,	3628.0	8.6	Bl.
	3620.1	9.4	Bl,			
195205 RR AQUILAE—						
	3665.5	11.2	Gd,	3679.6	10.5	M.
	3672.6	10.6	Pt,			
195308 RS AQUILAE—						
	3665.6	11.8	M,	3672.6	11.8	Pt,
	3666.8	12.1	Br,	3674.6	11.2	Sg.
195553 NOVA CYGNI #3—						
	3644.1	10.8	Ch,	3669.6	11.2	Pt,
	3654.6	11.0	L,	3675.6	10.8	Pt,
	3654.6	10.8	Pt,	3676.8	10.9	Sg,
	3660.6	10.7	Pt,	3679.7	11.0	Pt,
	3666.6	10.8	Pt,	3680.6	11.3	Pi.
195849 Z CYGNI—						
	3644.7	14.3	Wf,	3670.9	13.2	Wf,
	3647.8	14.2	Wf,	3672.6	12.8	Pt,
	3662.6	14.0	Wf,	3680.6	12.0	Pi.
195855 S TELESCOPII—						
	3611.0	12.9	Bl.			
200212 SY AQUILAE—						
	3640.6	12.2	L,	3666.7	13.7	Wf,
	3644.8	13.5	Wf,	3671.7	13.4	Wf,
	3651.4	12.6	L,	3672.6	12.7	Pt.
	3665.6	13.0	M,			
200357 S CYGNI—						
	3666.7	14.9	Wf,	3670.7	15.0	Wf.
200514 R CAPRICORNI—						
	3668.7	13.0	Br,	3672.6	12.8	Pt.
200747 R TELESCOPII—						
	3611.0	13.8	Bl,	3620.1	13.1	Bl.
200715a S AQUILAE—						
	3644.8	9.5	Wf,	3671.7	11.6	Wf,
	3647.8	9.6	Wf,	3672.6	11.5	Pt,
	3654.8	10.7	M,	3672.7	11.9	Br,
	3661.7	11.2	Wf,	3676.5	12.0	Gd.
	3666.7	11.4	Wf,			
200715b RW AQUILAE—						
	3654.8	9.2	M,	3676.5	9.9	Gd.
	3672.6	9.4	Pt,			
200812 RU AQUILAE—						
	3668.7	14.0	Br.	3671.7	14.3	Wf.
200822 W CAPRICORNI—						
	3672.6	12.0	Pt.			
200906 Z AQUILAE—						
	3665.5	10.4	Gd.	3672.6	9.2	Pt.
	3668.7	10.3	Br.			

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
200916 R SAGITTAE—				
	3654.8	9.0 M.		
200938 RS CYGNI—				
	3641.1	8.9 Ch,	3665.7	8.2 Sg,
	3645.4	8.4 L,	3672.6	7.8 Pt.
	3654.8	8.8 M,		
201008 R DELPHINI—				
	3640.6	12.3 L,	3668.7	13.0 Br,
	3645.7	12.3 Wf,	3671.7	12.8 Wf,
	3651.4	12.3 L,	3672.8	12.6 Pt.
	3666.7	12.7 Wf,		
201121 RT CAPRICORNI—				
	3649.4	6.4 L,	3672.8	6.3 Pt.
	3672.5	7.3 Ro,		
201130 SX CYGNI—				
	3645.7	12.0 Wf,	3668.7	12.7 Br,
	3654.8	11.4 M,	3671.7	12.8 Wf,
	3666.7	12.9 Wf,	3672.8	12.9 Pt.
201139 RT SAGITTARII—				
	3611.0	13.0 Bl,	3628.0	12.0 Bl,
	3621.9	12.5 Bl,	3673.6	10.0 Pt.
201437b WX CYGNI—				
	3638.7	10.1 Kl,	3656.6	10.5 Kl,
	3640.6	10.5 Kl,	3654.8	10.8 M,
	3644.6	10.5 Kl,	3661.6	10.5 Kl,
	3645.7	10.7Wf,	3666.7	10.2 Wf,
	3646.6	10.4 Kl,	3667.7	10.0 Sg,
	3649.6	10.4 Kl,	3669.7	10.4 Br,
	3649.7	10.4 Br,	3671.7	10.4 Wf,
	3651.6	10.5 Kl,	3672.8	10.4 Pt,
	3653.6	10.6 Kl,	3680.6	10.4 Pt.
201647 U CYGNI—				
	3662.5	7.8 Ro,	3673.5	8 0 Gd,
	3667.7	8.0 Sg,	3680.6	8.8 Pi,
	3668.7	7.8 Sg,	3680.8	7.8 Sg.
	3672.8	7.5 Pt,		
202240 U MICROSCOPII—				
	3610.0	12.7 Bl.		
202817 Z DELPHINI—				
	3666.7	14.0 Wf.	3672.8	13.6 Pt.
	3671.7	13.9 Wf,		
202946 SZ CYGNI—				
	3654.6	9.1 Pt,	3669.6	9.3 Pt,
	3654.8	9.0 M,	3672.6	9.3 Pt,
	3660.6	9.5 Pt,	3667.6	9.5 Pt,
	3666.6	9.1 Pt,	3678.8	8.9 Pt.
202954 ST CYGNI—				
	3645.7	13.4 Wf,	3671.7	13.5 Wf,
	3666.7	13.5 Wf,	3672.8	13.5 Pt.
	3669.7	13.5 Br,		
203226 V VULPECULAE—				
	3672.8	9.3 Pt.		
203429 R MICROSCOPII—				
	3611.0	9.3 Bl,	3628.0	8.8 Bl.
	3621.9	9.0 Bl,		
203611 Y DELPHINI—				
	3645.7	13.3 Wf,	3671.7	13.6 Wf,
	3666.7	13.5 Wf,	3672.8	13.6 Pt.
	3669.7	13.0 Br,		
203816 S DELPHINI—				
	3654.8	9.6 M,	3672.8	8.9 Pt.
	3665.6	9.3 O,		
203847 V CYGNI—				
	3641.1	11.5 Ch,	3672.8	9.8 Pt,
	3645.7	10.8 Wf,	3673.5	10.8 Gd,
	3658.7	11.0 Br,	3676.8	10.0 Sg,
	3666.7	10.5 Wf,	3680.6	10.7 Pi.
	3671.7	10.6 Wf,		
203905 Y AQUARII—				
	3665.7	10.0 Sg,	3672.8	10.3 Pt.
	3669.6	10.2 Mh,		
204016 T DELPHINI—				
	3645.7	12.5 Wf,	3666.7	12.0 Wf,
	3646.7	12.8 Br,	3669.7	12.0 Br,
	3649.7	12.3 Br,	3671.7	11.9 Wf,
	3665.6	12.0 M,	3672.8	11.6 Pt.
204102 V AQUARII—				
	3672.8	8.8 Pt.		
204104 W AQUARII—				
	3645.4	12.0 L,	3669.7	12.2 Pt.
204405 T AQUARII—				
	3639.2	11.5 Ch,	3672.8	14.0 Pt.
204846 RZ CYGNI—				
	3645.7	12.6 Wf,	3671.7	12.4 Wf,
	3658.7	12.5 Br,	3672.8	12.3 Pt.
	3666.7	12.4 Wf,		
205017 X DELPHINI—				
	3646.7	12.6 Br,	3666.7	13.5 Wf,
	3647.7	12.7 Wf,	3671.7	13.6 Wf,
	3649.7	13.0 Br,	3672.7	13.4 Br.
205923 R VULPECULAE—				
	3644.8	13.0 Wf,	3666.7	13.6 Wf,
	3647.8	12.8 Wf,	3671.7	13.4 Wf,
	3649.7	13.2 Br,	3672.7	13.5 Br,
	3654.8	12.2 M,	3673.6	13.2 Pt.
	3661.7	13.2 Wf,		
210124 V CAPRICORNI—				
	3611.0	10.4 Bl,	3628.0	11.4 Bl.
210129 TW CYGNI—				
	3645.7	13.3 Wf,	3671.7	12.2 Wf.
	3666.7	12.4 Wf,		
210382 X CEPHEI—				
	3645.7	13.6 Wf,	3671.7	14.1 Wf.
	3666.7	14.2 Wf,		
210504 RS AQUARII—				
	3645.4	12.9 L,	3673.6	11.4 Pt.
	3672.7	11.7 Br,		
210516 Z CAPRICORNI—				
	3672.7	9.0 Br,	3673.6	9.0 Pt.
210812 R EQUULEI—				
	3645.7	9.1 Wf,	3671.7	8.9 Wf,
	3665.6	8.9 O,	3672.7	9.3 Br,
	3666.7	8.9 Wf,	3673.6	8.9 Pt.

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
210868 T CEPHEI—						
	3638.7	7.2	Kl,	3655.2	8.0	Ch,
	3639.4	7.0	L,	3656.6	7.7	Kl,
	3640.2	7.8	Ch,	3659.5	7.6	Sg,
	3641.6	7.2	Kl,	3661.6	7.8	Kl,
	3644.6	7.3	Kl,	3662.6	8.8	O,
	3646.6	7.2	Kl,	3667.6	8.3	Sg,
	3649.6	7.3	Kl,	3668.8	8.0	Sg,
	3651.3	7.6	L,	3673.6	8.1	Pt,
	3651.6	7.3	Kl,	3677.6	8.3	Sg.
	3653.6	7.4	Kl,			
210903 RR AQUARII—						
	3672.7	9.5	Br,	3673.6	9.4	Pt.
211614 X PEGASI—						
	3644.8	13.7	Wf,	3671.7	14.2	Wf,
	3647.8	13.0	Wf,	3672.8	13.2	Br.
	3666.7	14.2	Wf,			
211615 T CAPRICORNI—						
	3611.0	8.8	Bl,	3673.6	11.3	Pt.
	3628.0	8.9	Bl,			
212030 S MICROSCOPII—						
	3611.0	11.4	Bl,	3628.0	12.5	Bl.
213244 W CYGNI—						
	3640.3	6.6	An,	3649.4	5.7	L.
213678 S CEPHEI—						
	3645.7	9.6	Wf,	3671.7	9.6	Wf,
	3666.7	9.6	Wf,	3673.6	8.8	Pt.
213753 RU CYGNI—						
	3646.1	8.6	Ch,	3673.6	8.1	Pt.
213843 SS CYGNI—						
	3634.4	8.3	L,	3663.3	11.6	L,
	3635.4	8.4	L,	3663.5	11.5	Sg,
	3636.2	8.4	Ch,	3664.6	11.5	Sg,
	3636.4	8.6	L,	3664.7	11.9	Br,
	3638.2	9.6	Ch,	3665.6	11.5	O,
	3638.4	9.6	L,	3665.7	11.5	Sg,
	3638.6	10.0	Kl,	3666.6	11.7	Cd,
	3639.1	9.8	Ch,	3666.7	11.9	Br,
	3639.4	9.8	L,	3666.7	11.8	Wr,
	3640.2	11.0	Cl,	3667.5	11.5	Sg,
	3640.6	11.1	L,	3667.5	11.8	Cd,
	3641.1	11.2	Ch,	3667.6	11.5	Fe,
	3641.6	11.1	Kl,	3667.6	11.5	O,
	3642.1	11.3	Ch,	3667.7	11.8	Br,
	3642.3	11.8	Pe,	3668.6	11.8	Pt,
	3642.4	11.2	An,	3668.7	12.0	Br,
	3642.4	11.1	L,	3668.7	11.7	Wf,
	3644.2	11.8	Ch,	3669.6	11.8	Pt,
	3644.6	11.5	Kl,	3669.7	11.6	Sg,
	3644.9	11.8	Wf,	3669.7	11.8	Br,
	3645.4	11.3	L,	3669.7	11.6	Wf,
	3645.7	11.8	Wf,	3670.7	11.8	Br,
	3646.1	11.7	Ch,	3670.8	11.9	Wf,
	3646.6	11.3	Kl,	3671.7	11.8	Wf,
	3646.7	11.7	Br,	3671.8	12.0	M,
	3647.7	11.7	Br,	3672.5	11.6	Ro,
	3647.8	11.8	Wf,	3672.6	11.8	Pt,
	3648.4	11.5	L,	3672.6	11.0	Ly,
	3648.7	11.8	Br,	3672.6	11.5	Fe,
	3648.8	11.3	Wf,	3672.7	11.7	Wf,
	3649.4	11.5	L,	3672.7	11.9	Br,
	3649.6	11.6	Kl,	3673.5	11.6	Ro,
	3649.7	11.9	Br,	3673.5	11.9	Gd,
	3649.8	11.3	Wf,	3673.6	10.5	Ly,
	3650.7	11.8	Br,	3673.6	11.9	Pt,
	3650.7	11.8	Sg,	3673.7	11.6	Wf,
	3651.3	11.5	L,	3673.7	11.9	Br,
	3651.6	11.4	Kl,	3674.5	11.6	Sg,
	3652.1	11.7	Ch,	3674.6	11.5	Ly,
	3652.6	11.8	Pt,	3674.6	11.3	O,
	3652.6	11.8	Cd,	3674.6	11.5	Ya,
	3652.6	11.7	L,	3674.7	11.7	Br,
	3653.6	11.2	Kl,	3675.5	11.3	Ro,
	3653.7	11.7	Br,	3675.6	11.8	Pt,
	3654.6	11.8	Pt,	3675.6	11.6	Fe,
	3654.6	11.8	L,	3676.5	11.9	Gd,
	3655.2	11.7	Ch,	3676.6	11.8	Pt,
	3655.7	11.8	Br,	3676.8	11.8	Sg,
	3655.8	11.8	Pt,	3677.5	11.7	Sg,
	3656.6	11.5	Kl,	3677.6	11.5	O,
	3656.6	11.8	Pt,	3677.6	11.5	Em,
	3656.7	11.7	Br,	3677.6	11.8	Pt,
	3658.7	11.7	Br,	3677.6	11.5	Ya,
	3659.5	11.7	Cd,	3678.6	11.5	O,
	3659.7	11.8	Br,	3678.8	11.6	Pt,
	3660.6	11.7	Pt,	3679.5	10.8	Ro,
	3660.7	[10.9	Sg,	3679.6	11.1	Ya,
	3660.7	11.7	Br,	3679.6	11.1	O,
	3661.3	11.6	L,	3679.6	10.5	Ly,
	3661.6	11.0	Kl,	3679.6	11.1	Em,
	3661.6	11.5	Ly,	3679.7	10.2	Pt,
	3661.6	11.6	Pt,	3679.7	10.2	M,
	3661.7	11.7	Br,	3679.7	9.8	Ly,
	3661.7	11.4	Wf,	3680.6	10.0	Ly,
	3662.3	11.3	L,	3680.6	10.0	Pi,
	3662.5	11.6	Sg,	3680.6	9.9	Cd,
	3662.5	11.6	Ro,	3680.6	9.6	O,
	3662.6	11.4	Fe,	3680.7	9.7	Sg,
	3662.7	11.6	Wf,	3682.5	9.2	Sg,
	3663.3	11.3	An,	3682.5	8.5	Ly.
213937 RV CYGNI—						
	3673.7	6.8	Pt.			
214024 RR PEGASI—						
	3645.7	10.3	Wf,	3671.7	11.1	Wf,
	3650.7	10.4	Br,	3673.7	10.7	Pt,
	3666.7	10.6	Wf,	3673.7	10.7	Br,
	3667.6	10.6	O,	3675.8	10.8	M.
214247 R GRUIS—						
	3611.0	13.1	Bl,	3628.0	12.4	Bl.
215605 Y PEGASI—						
	3645.7	9.7	Wf,	3667.6	9.0	O,
	3650.8	9.0	Br,	3671.7	8.7	Wf,
	3666.7	9.7	Wf,	3673.7	9.3	Pt.
215717 U AQUARII—						
	3673.7	11.8	Pt.			
215934 RT PEGASI—						
	3668.7	10.8	Sg,	3673.7	11.0	Br,
	3673.7	11.0	Pt,	3675.8	11.6	M.

VARIABLE STAR OBSERVATIONS, August 20 to September 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
220133a RY PEGASI—						
	3673.7	11.5	Pt.			
220133b RZ PEGASI—						
	3650.7	12.0	Br.	3673.7	11.9	Pt.
	3673.7	11.5	Br.			
220412 T PEGASI—						
	3645.4	12.7	L.			
220714 RS PEGASI—						
	3673.7	9.9	Pt.			
222439 S LACERTAE—						
	3642.6	8.5	An,	3663.4	8.4	An,
	3642.6	8.3	L,	3673.7	8.1	Pt.
	3663.4	8.1	L,			
222867 R INDI—						
	3611.0	10.4	Bl.	3628.0	9.6	Bl.
223841 R LACERTAE—						
	3642.4	13.9	L.			
225914 RW PEGASI						
	3654.8	10.6	M.	3673.7	13.4	Pt.
230110 R PEGASI—						
	3673.7	12.8	Pt.			
230759 V CASSIOPEIAE—						
	3650.8	11.8	Br,	3673.7	12.0	Pt.
231425 W PEGASI—						
	3645.4	12.0	L,	3658.7	11.3	Br.
231508 S PEGASI—						
	3637.4	10.3	Pe,	3673.7	12.4	Pt.
232848 Z ANDROMEDAE—						
	3659.8	9.7	Ct.	3673.7	9.8	Pt.
	3668.9	9.5	Ct.	3674.7	9.4	Ct.
	3672.6	9.5	Ct.			
233335 ST ANDROMEDAE—						
	3639.2	10.5	Ch,	3663.6	10.1	O,
	3645.7	10.6	Wf,	3666.7	9.8	Wf,
	3655.7	10.2	Br,	3671.7	9.8	Wf,
	3660.7	10.2	Sg,	3673.7	8.8	Pt.
233815 R AQUARII—						
	3644.2	9.6	Ch.	3673.7	9.0	Pt.
	3668.7	9.1	Sg.			
233956 Z CASSIOPEIAE—						
	3645.7	13.1	Wf,	3671.7	13.6	Wf.
	3669.7	13.6	Wf,			
235209 V CETI—						
	3640.6	12.2	L,	3673.7	10.1	Pt.
	3652.6	11.4	L,			
235350 R CASSIOPEIAE—						
	3650.8	12.2	Br.			
235525 Z PEGASI—						
	3673.7	13.0	Pt.			
235855 Y CASSIOPEIAE—						
	3661.7	12.2	Br.			
235939 SV ANDROMEDAE—						
	3673.7	12.5	Pt.			

Total observations: 1642; Stars: 304; Observers: 27.

The following observers contributed to this report: Messrs. Ancarani "An", Baldwin "Bl", Braid-White "Bw", Brocchi "Br", Calvin "Cv", Carr "Ca", Chandler "Cd", Chandra "Ch", Christie "Ct", Cilly "Cy", Miss Clough "Cg", Elmer "Em", Ferry "Fe", Godfrey "Gd", Kleis "Kl", Lacchini "L", Mrs. Lytle "Ly", Marshall "Mh", McAteer "M", Olcott "O", Peltier "Pt", de Perrot "Pe", Pickering "Pi", Rhorer "Ro", Skaggs "Sg", Waterfield "Wf", Yalden "Ya".

HOWARD O. EATON, Recording Secretary.

SUMMARY OF ANNUAL REPORTS.

Year	Observations	Stars	Observers
1912	6,180	175	19
1913	12,914	200	20
1914	14,506	255	28
1915	14,724	282	29
1916	11,261	290	30
1917	15,788	332	43
1918	16,112	380	34
1919	8,710	352	53
1920	9,099	395	69
1921	15,513	386	77
1922	16,994	372	72
1923	17,745	441	68
Totals	159,546	441	160

ANNUAL REPORT OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
1922-1923.

Observer	Initial	1922 November	1922 December	1923 January	1923 February	1923 March	1923 April	1923 May	1923 June	1923 July	1923 August	1923 September	1923 October	Totals	Telescope
Ancarani, M.	An	18	16	22	3	11	22	14	..	..	10	15	32	163	3
Aurino, S.	Au	..	..	42	..	..	17	..	26	54	..	..	..	139	6
Baldwin, J. M.	Bl	..	..	117	173	157	151	158	194	172	168	157	174	1621	8
Bouton, Rev.	B	62	85	146	82	32	52	133	33	..	..	..	..	625	6
Brocchi, D. F.	Br	139	89	58	20	78	43	50	59	..	23	110	98	767	6
Carr, F. J.	Ca	52	51	..	..	..	..	..	43	50	52	77	104	429	3
Chandler, F. H.	Cd	..	..	..	14	..	16	19	20	..	6	5	9	89	3
Chandra, R. G.	Ch	93	84	111	76	103	147	..	70	110	93	80	68	1035	3
Christie, W. H.	Ct	59	79	29	..	..	67	40	21	19	8	..	14	336	2
Cilly, M.	Cy	..	..	..	..	..	..	..	..	..	4	14	20	38	6r
Clough, Miss Inez	Cg	12	6	..	..	..	..	..	5	..	..	..	9	32	3
Cunningham, L. E.	Cu	..	..	1	45	24	24	..	..	..	..	..	..	94	2
Fant, A. T.	Ft	..	..	..	..	..	..	..	3	..	5	10	..	18	
Ferry, P. D.	Fe	..	..	..	..	..	..	..	..	..	27	22	18	67	6
Ginori, N. V.	Gi	64	34	100	47	31	..	74	52	84	43	61	..	590	9
Godfrey, C. C.	Gd	22	22	..	..	..	..	..	..	14	24	..	9	91	8r
Hunter, S. C.	Hu	26	24	13	..	..	..	..	..	..	..	..	..	63	8
Jacobsen, T. S.	Jb	..	..	30	14	..	14	..	..	..	20	..	..	78	5
Jenkins, Miss L.	Jk	..	17	..	..	..	25	..	..	..	13	..	..	55	3
Jordan, M.	Jd	16	27	17	..	..	..	..	..	..	..	..	..	60	6
Kanda, S.	Kd	22	52	56	125	102	70	83	50	31	26	30	..	647	2
Kleis, L. E.	Kl	..	..	..	..	..	..	..	13	32	73	..	97	215	5
Lacchini, G. B.	L	118	57	88	71	165	53	167	161	102	80	126	138	1326	5
Leavenworth, F.	Lv	..	66	78	13	49	24	10	25	39	12	69	..	385	10
Lytle, Mrs. C. C.	Ly	..	..	..	..	..	..	28	..	..	22	30	17	97	4
Marshall, R	Mh	..	..	..	2	6	18	..	7	..	..	..	6	39	3
McAteer, C. Y.	M	28	88	39	46	22	40	50	107	39	71	75	69	674	5,13
Nakamura, K.	Nk	201	85	..	72	..	..	17	8	..	45	29	..	457	4,10
Olcott, W. T.	O	26	65	26	..	..	..	..	49	21	28	11	40	266	5
Paraskevopoulos, Dr. S. J.	Jp	165	97	..	..	..	..	..	..	..	..	..	..	262	16
Paraskevopoulos, Mrs. S. J.	Dp	164	97	..	..	..	..	..	..	..	..	..	..	261	16
Parkhurst, J. A.	Pa	..	..	..	..	..	..	..	17	..	26	..	..	43	40
Peltier, L.	Pt	287	261	247	226	243	203	293	272	240	283	279	287	3121	6
de Perrot, E.	Pe	50	..	..	..	..	7	..	9	..	26	..	44	136	4
Pickering, D. B.	Pi	..	..	..	..	..	..	..	23	..	..	..	11	34	8r
Proctor, S. K.	Pc	..	17	..	10	..	..	18	..	..	..	..	..	45	12
Rhorer, S. L.	Ro	27	13	..	..	..	..	20	14	..	52	20	18	164	5
Skaggs, J. H.	Sg	51	65	18	60	43	24	47	74	57	90	65	60	654	5
Suter, R. O.	Su	9	..	..	..	..	..	13	9	17	..	..	..	48	3
Townley, S. D.	To	..	45	23	..	..	..	..	44	..	65	..	..	177	5
Waterfield, W.	Wf	250	120	22	..	178	..	101	..	340	161	227	279	1678	12r
Watson, P. S.	Pw	..	..	5	4	11	11	..	..	..	..	..	..	31	6
Yalden, J. E. G.	Ya	11	24	13	15	16	12	22	35	6	22	..	8	184	4
Young, Miss A.	Y	32	28	52	13	33	24	5	8	..	..	..	..	195	8
24 others		32	21	15	26	..	27	4	69	3	3	3	13	216	
Total observations		2036	1735	1368	1157	1304	1091	1366	1520	1430	1581	1515	1642	17745	
Observers per month:		27	33	25	22	18	24	25	38	26	31	23	27	68	
Stars observed:		296	276	347	380		287	355	352		...		304	441	

GENERAL NOTES

Professor Giovanni Zappa, director of the Roman College Observatory, died on September 14, 1923, at the age of 39 years.

M. Jean Bosler, assistant astronomer at the Paris Observatory, has been appointed director of the Marseilles Observatory, succeeding the late M. Bourget.

Dr. Robert H. Baker, professor of astronomy in the University of Missouri, has been appointed professor of astronomy in the University of Illinois.

Dr. Eli Stuart Haynes, professor of astronomy at Beloit College, has been chosen to succeed Dr. Robert H. Baker at the University of Missouri.

Dr. Frederick C. Leonard, in charge of the astronomical work at the Southern Branch of the University of California in Los Angeles, at the invitation of President Reinhardt and Professor E. G. Linsley, on August 31 addressed the student assembly of Mills College, Oakland, Calif., on the subject of "Our Place in the Universe." In the afternoon, Dr. Leonard spoke to pupils of the Cora L. Williams Institute, of Berkeley, Calif., on "The Total Solar Eclipse of September 10, 1923.

Professor Delonza Tate Wilson, of the department of Astronomy of Case School of Applied Science, Cleveland, Ohio, died on Friday, October 12, at the Kendall House Sanitarium, Washington, D. C., after a long illness.

A member of the faculty at Case for twenty years, Dr. Wilson did a great deal in building up the department of astronomy and in teaching mathematics. When the Warner and Swasey Observatory, dedicated in 1920, was being planned, he assisted in the designing of the building and its equipment. He made a special study of ballistics and during the war taught classes in that subject, co-operating with the Government Naval College and the Coast Artillery Division. The special astronomical research to which he gave his attention was the computation of the perturbations of a group of asteroids, printed at Upsala in 1912.

Dr. Wilson was born in Clinton, N. C., soon after the close of the Civil War. He was graduated from the University of North Carolina in 1887, received his M. A. from Vanderbilt University in 1896, and his Ph. D. from the University of Chicago in 1905. He spent a number of years as a computer in the United States Observatory at Washington, then taught two years, 1901-1903, at the University of Cincinnati, before coming to Case in 1903 as an assistant professor. He was made an associate professor in 1911. Illness compelled him to give up his work at the end of the college year in 1921.

A brother and a sister survive him; he was unmarried. Interment was at Clinton, N. C. Dr. Wilson was a very congenial, likable man, and a splendid teacher. He was a member of Beta Theta Pi.

Charles Burckhalter. — Popular astronomical education suffers a loss in the death of Charles Burckhalter, who had been for thirty-eight years director of the Chabot Observatory of Oakland. This institution, the property of the

Board of Education of the City, is equipped with an eight-inch and a twenty-inch refractor, and is used for the popular education of boys and girls in grades and high school.

During Mr. Burckhalter's service, the Observatory had been moved from the center of the City of Oakland, and located more favorably in a splendid building, and the twenty-inch telescope added.

Mr. Charles Burckhalter was born in Taylorsville, Ohio, January 5, 1849, and passed away September 20, 1923.

Professor Earle G. Linsley, Department of Astronomy in Mills College, has been appointed his successor. Professor Linsley has been associated with Mr. Burckhalter for several years on a voluntary basis, while he gave instruction at Mills College. He brings to the Observatory enthusiasm, experience, optimism, and skill in administration and high reputation as a teacher.

What Others Think.—The following clipping, from the *Milwaukee Journal*, shows something of the kindly feeling which men in other walks of life have for those who are working to add to our sum of exact knowledge.

THE ECLIPSE OF HOPES.—An eclipse of the sun, total only in a small zone along the California coast. The country is interested, unusually interested. Astronomers are interested. These persevering and enthusiastic searchers of the sky find in such an event one of their great occasions. They have called on inventive power and used great telescopes to learn ever more and more about the elements of the sun. They have found out much that was deemed impossible a few generations ago. But there are many other things they can investigate only during the favoring opportunity of an eclipse. Day by day and year by year they set aside questions, calculations to be checked up. What a great reward if they find their conclusions certified by direct observation! What a still greater reward if they glean some new thing!

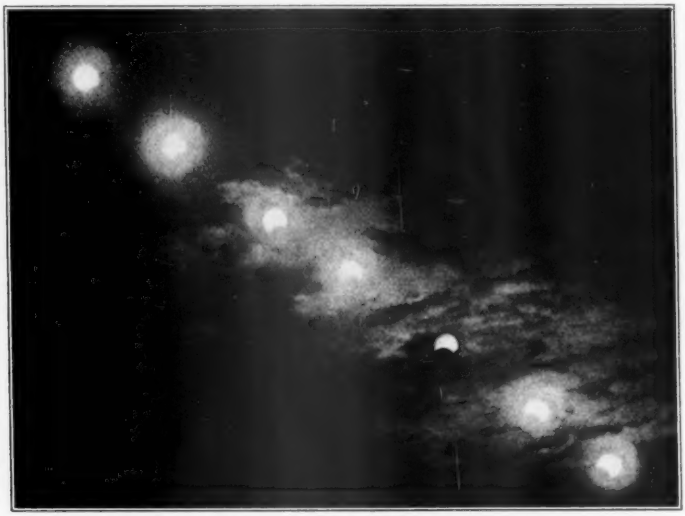
Then the eclipse fails. Clouds, smoke, mist, haze—one or all get in the way. Only a few meager photographs reward the great preparations. And to some of these men who have given lifetimes to their work there will come no other such opportunity. No layman's sympathy is adequate to such a disappointment.

What do they do? Give up? Not one of them. They go back to the tasks for which every clear day and night suffices. Measuring distances, calculating inconceivable things, testing their conclusion by new observation and—gathering data for those who will watch the next eclipse. With their eyes on celestial objects unimaginable millions of miles away, they expect disappointment today and tomorrow, while they build for futures a dozen or a hundred centuries to come. Almost daily they uncover for us facts which illumine our knowledge not of the heavens only, but of the planet on which we live. Their hopes have suffered eclipse, but their work is founded on something more than the chance of a cloudy day. And they press on, content if what they do endures and proves a safe foundation for the builders who follow.—*Milwaukee Journal.*

Eclipse Photographs. — We have been delayed somewhat this month by the difficulty in getting satisfactory reproductions of the fine eclipse photographs which have been sent in by kindness of the directors of the Sproul Observatory and of the Mexican National Observatory. They are to be congratulated in having obtained such excellent results in spite of the cloudy weather which came so near frustrating their efforts.

The following photographs of the partial phases of the eclipse of September 10 will also be interesting to many of our readers.

PHOTOGRAPHS OF THE PARTIAL ECLIPSE OF THE SUN, SEPTEMBER 10, 1923.
taken by B. Takaji, at San Diego, California.



PHOTOGRAPHS OF THE PARTIAL ECLIPSE OF THE SUN, SEPTEMBER 10, 1923.
taken by Chester Billings, Rochester, Vermont.

New Comet (Dubiago).—A telegram received from Harvard College Observatory Oct. 27 announces the discovery of a comet by Dubiago of Kasan, Russia, on October 14, in the following position:

G.M.T.	R.A.	Decl.
Oct. 14.5542	$7^h\ 46^m\ 42^s.7$	$-20°\ 37'\ 31''$

The magnitude is given as eight and the daily motion 1° 40′ east, 4° 51′ south.

The position given would place the comet, at the time of discovery, in the constellation Argo, about fifteen degrees southeast of Sirius. The unusually rapid motion indicated would have carried the comet to a very different part of the sky before the announcement reached American observers. No further word has been received concerning the comet, up to the time of locking up the forms of this issue of POPULAR ASTRONOMY.

Fuertes Observatory Eclipse Observations. – The following observations of the partial phase of the Eclipse of September 10, 1923, have been sent in by Professor Samuel L. Boothroyd, director of the Fuertes Observatory, Cornell University, Ithaca, New York.

First contact $3^h\ 38^m\ 36^s.1$ Eastern Standard Time.
Last contact 5 24 24 .2 " " "

The times are probably correct to the nearest second. The position of the Observatory is

Latitude $+ 42°\ 27'\ 12''$
Longitude $5^h\ 05^m\ 54^s.3$ west from Greenwich.

Internal Motion in the Spiral Nebula N. G. C. 5055. — In contributions from the Mt. Wilson Observatory, No. 255, Dr. A. van Maanen reports on his measures of photographs of this spiral. He used two plates taken with the 60-inch reflector, the first in 1910 and the second in 1922. Twenty-one comparison stars and 98 nebular points were measured. The results obtained agree with similar measures made of other spirals in that they show motions outward along the spiral arms as well as rotation about the center, the rotation being such that the concave side of the arms is the forward side.

Radial Velocities of 1013 Stars. — In contributions from the Mt. Wilson Observatory, No. 258, Adams and Joy give the results obtained from spectrograms taken with the 60-inch and 100-inch reflectors. The spectrographs used had one prism and short focus camera lenses. The stars in the list are almost wholly of spectral types F to M. Radial velocities of 109 of the stars have been obtained at the Lick Observatory and of 83 at the Dominion Astrophysical Observatory. A systematic difference Mt. W. minus Lick of —0.12 km and Mt. W. minus D. A. O. of +0.8 km was found. This agreement appears to be exceptionally good considering the small dispersion used.

A Study of the Green Auroral Line. – Contributions from the Mt. Wilson Observatory, No. 259, contains some interesting results on this subject by Babcock who used a Fabry-Perot interferometer. The wave-length of the line was found to be $5577.350 \pm .005$. The observations were made on the continuous aurora reported by a number of observers as existing over the entire sky. A number of plates were obtained which showed such variations in brightness

between them that there is good reason to believe that the difference is due to actual variation in the brightness of the continuous aurora. Good plates were obtained with exposures of only 7 hours. As this is only a small fraction of the time required for spectrograms obtained with a slit spectrograph it opens a new field of investigation of great interest.

Comas Solá's Star 2.1923 Librae. — In a communication published April 25, 1923, as Circulaire No. 16 of the Bureau Central Astronomique, Comas Solá announces a single very rapid rise in brightness of a twelfth magnitude star for which the position for 1923 is $15^h\,14^m.2$, —8° 11′. He suggests that the star may be a variable, or a "small" nova (Bull. Soc. Ast. de France **37**, 314, 1923; B.Z. No. 12, 1923).

The object has been examined on seventy-four Harvard photographs, several of which were made for the purpose. Fourteen maxima, when the magnitude is brighter than 11.5, were found. It appears, therefore, that the star is a periodic variable with sharp maxima. The observations made in 1923 are well represented by a period of 0.369 days.

The following photographic magnitude sequence (1922 standards) has been established through comparison with the standards at $15^h.0$, —15°.

Designation	B.D.	R.A. 1900 h m	Dec. 1900 ° ′	Magnitude	Spectrum
Var.	.. ..	15 13.0	—8 6	..	..
a	—7°3992	15 11.5	—7 54	7.8	G5
b	—7 3999	15 13.2	—8 2	8.1	K0
c	—8 3937	15 11.9	—8 15	8.9	F0
d	—7 3991	15 11.2	—7 50	10.2	..
e	—7 3996	15 12.4	—7 52	10.7	..
f	.. ..	15 13.2	—8 1	11.1	..
g	—8 3942	15 13.1	—8 17	11.4	..
h	.. ..	15 12.7	—8 16	11.6	..
k	.. ..	15 12.5	—7 55	11.8	..
l	.. ..	15 12.9	—7 58	12.2	..
m	.. ..	15 12.4	—8 1	12.5	..
n	.. ..	15 12.7	—8 4	12.8	..

The extreme range is from magnitude 10.8 to 12.5, which is larger than usual for cluster type Cepheids. The galactic coordinates are 322°, + 38°. The spectral class is unknown. The variable will be studied further at this observatory.

Harvard College Observatory Bulletin 791.

The Three Tests of the Einstein Theory.—When Einstein had elaborated his theory of relativity he suggested three tests for it and asserted that all of them must hold or the theory would have to be given up. The first of these was the rotation of the line of apsides of the planetary orbits; the second the deviation of a ray of light passing through a strong gravitational field; the third a slight increase in the wave-lengths of the lines in the spectrum of a source in a strong gravitational field.

The first test was used in connection with the movement of the perihelion of Mercury's orbit. Many years ago Leverrier showed that this movement is about 40″ per century more than can be accounted for by the attraction of all known planets. Various attempts have been made to account for this motion by assuming that the matter causing the zodiacal light might be sufficient to do this. Thus Seeliger found that if the total mass of this material amounted to one-third that of Mercury the motion of the perihelion could be accounted for. We do not

know the mean density of the zodiacal light nor do we know the distribution of its density. The theory has therefore found comparatively few adherents. In the meantime the Einstein theory was found to meet the situation with such exactness that it was generally considered to have met the first test.

The second test seemed to have been met when the two English expeditions published their results for the total eclipse of 1919. However the results were questioned by many for one reason or another so that the publication of the results of the Crocker eclipse expedition of the Lick Observatory for the eclipse of 1922 were awaited with great interest. In Lick Observatory Bulletin No. 346, Campbell and Trumpler announce that their plates show conclusively that a ray of starlight is bent out of its course when it passes near the sun. They publish

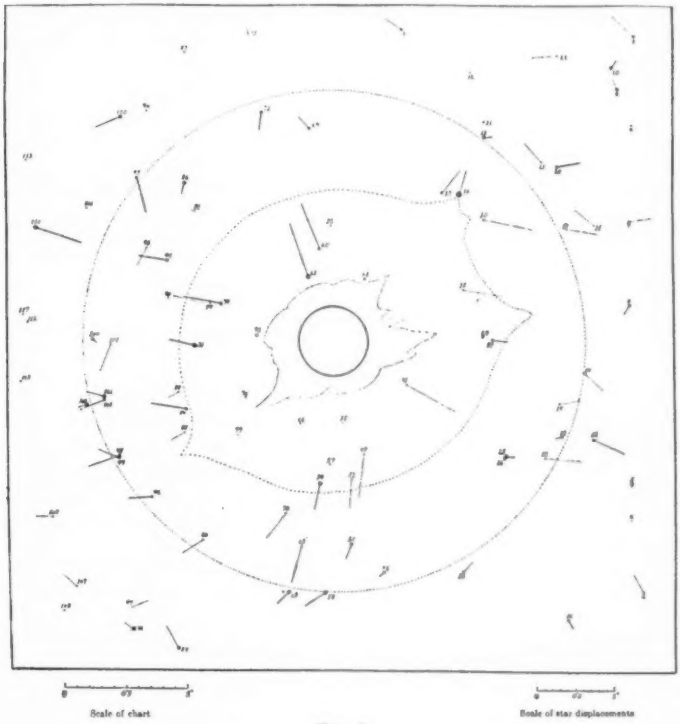


FIG. 1.

two diagrams which are here reproduced. Fig. 1 shows the field of stars around the eclipsed sun as well as the direction and relative amount of the deviation. It is quite evident that the displacement is radial and decreases with increasing distance from the sun's limb.

Fig. 2 shows these deviations in another way. The dotted curve is the theoretical deviation according to the Einstein theory and the dots show the deviations measured for the various stars. Any fairly drawn mean curve through the dots

would fall so nearly on the predicted curve that we must agree that the second test has been met.

The third test was announced as met by several European observers but

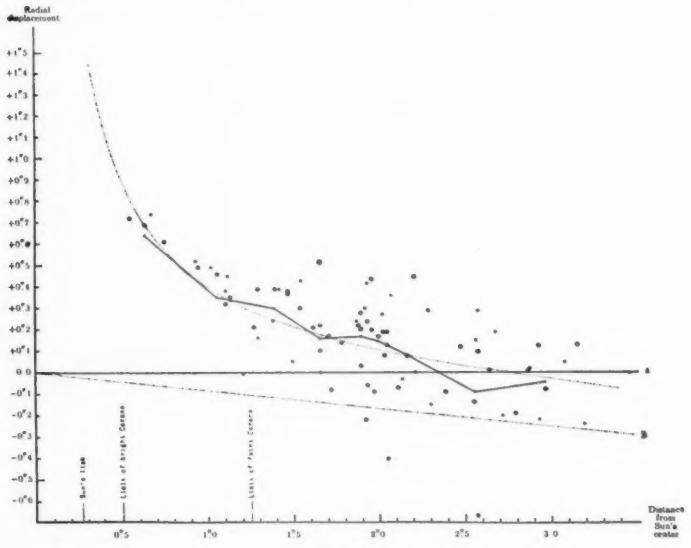


FIG. 2.

many hesitated to accept their results because the Mt. Wilson observers had failed to find them. However, at the meeting of the American Astronomical Society in Los Angeles in September, Dr. St. John of the Mt. Wilson Observatory announced that he too had verified the change in wave-lengths of many lines in the solar spectrum and would henceforth feel the necessity of taking the Einstein theory into account in his work on solar wave-lengths.

The three predictions of Einstein have therefore been verified and his theory of relativity firmly established in consequence.

Space Velocity of O-type Stars.—As the result of faulty transcription from a letter received from Dr. J. S. Plaskett, it is erroneously stated in Harvard Bulletin 788 that the space velocities of the O-type stars are approximately the reflex of the Sun's motion. The statement should read that the suggested interstellar calcium clouds are approximately stationary with respect to the stellar system from which the solar velocity is derived. The O-type stars appear in many cases to have fairly high space velocities.

Harvard College Observatory Bulletin 791.

The Star β Ceti. — Reports are given in the October number of *L'Astronomie* of observations of β Ceti by three observers in July, August and September. These reports indicate that the star was of its normal brightness.

Nine New Variables in High Galactic Latitude.—An indication of the thickness of the discoidal stellar system may be obtained through the study of Cepheid variables and other giant stars in high galactic latitude. The distribution in space of all known Cepheids, outside of the globular clusters and the Magellanic Clouds, was examined in detail by the writer a few years ago (Mt. W. Contr. 153, 1917). Very few Cepheids with $P > 1^d$ were then, or later, found to be more than a thousand parsecs from the plane of the Milky Way. Among the cluster type Cepheids, however, with $P < 1^d$, nearly one half are more distant than one thousand parsecs from the galactic plane. Some very distant cluster type variables have been found, at Harvard and Bergedorf in recent years, in the vicinity of globular clusters; but they may be variables escaping from the clusters, rather than representatives of the outer regions of the galactic system.

The Cepheids give a direct numerical value of the distance as soon as their periods and apparent magnitudes are determined. All those for which the median apparent photographic magnitude is fainter than thirteen, are at a greater distance than four thousand parsecs. Recent studies of the long period variables indicate that they also will be of value in giving qualitative estimates of distances.

To increase the available data bearing on the thickness of the Galaxy and to extend the work on Cepheids to fainter stars, there has been undertaken at Harvard a systematic search for variable stars in high galactic latitude. The photographs employed are made with the 16-inch Metcalf telescope, with exposures from twenty to forty minutes. They show stars to the fifteenth magnitude and fainter. Pairs of plates for 214 regions have been examined. Between four thousand and six thousand stars are shown on the average photograph, most of them undoubtedly being dwarf stars at no great distance from the Sun.

Seventeen new variables have been found by Miss Woods in the course of this survey, and the variability has been confirmed by Miss Cannon or the writer. Fourteen known variables were rediscovered. (Incidentally fifteen known asteriods were identified). Several of the new variables have been announced in earlier Bulletins. A list of the nine found most recently is given in the table below, which is followed by notes referring to the individual variables.

H. V. 3688 appears to be a variable of very short period. The ranges of variation, shown by the last two columns of the table, indicate that some of the others may be long period variables.

Harvard Variable	R.A. 1900	Dec. 1900	Galactic Long.	Galactic Lat.	Max. Mag.	Min. Mag.
	h m	° ′	°	°		
3680	14 7.9	+18 0	338	+68	11.6	13.0
3681	14 54.0	+41 8	35	+59	12.7	[15.6
3682	15 51.7	+ 9 19	347	+41	11.6	[13.8
3683	16 5.9	+32 13	19	+46	14.0	15.5
3684	17 38.6	+17 34	9	+22	11.6	[15.0
3685	22 12.5	+27 22	53	−24	13.8	[15.6
3686	22 17.1	+13 16	45	−36	13.5	15.7
3687	22 19.5	+26 14	54	−26	11.9	13.8
3688	22 22.5	+16 18	48	−34	11.4	13.3

3681 A star of the sixteenth magnitude precedes 2ˢ.3 and is 18″ south.
3683 A star of the fifteenth magnitude precedes 0ˢ.2 and is 14″ south.
3684 A star of the fifteenth magnitude precedes 0ˢ.3 and is 60″ south.
3686 A star of the fourteenth magnitude precedes 2ˢ.4 and is 27″ north.
3687 This variable is B.D.+ 26°4421. It is probably an eclipsing binary.

Harvard College Observatory Bulletin 791.

An Astronomer Talks on An American Orientalist.—A survey of the work of Professor James H. Breasted, Director of the Oriental Institute of the University of Chicago, and an appreciation of the tremendous service which he has rendered in bringing to light the civilizations of the ancient East, is made in the October number of Scribner's Magazine by Dr. George Ellery Hale, eminent astronomer and Director of the Mount Wilson Observatory at Pasadena. Dr. Hale spent last winter with Professor Breasted at Luxor where the orientalist was working with Lord Carnarvon and Howard Carter in excavating the tomb of King Tut-Ankh-Amen and he is thoroughly familiar with the problems and difficulties involved from first-hand observations.

In his article which is called "The Work of an American Orientalist" Dr. Hale says that the place to view the wonders of the world which gives the widest scope to the imagination is the cliffs above Thebes with its view of the valley of the Nile. From here one can see evidences of the evolution of the world from prehistoric times, back to the sun of which the earth once formed a part, Dr. Hale shows, and goes on to say: "Such a survey, with all the enlightenment its adequate development would bring, is the means naturally employed by any man of science to broaden his conception of his particular field of research. Nothing is more stimulating or more practically useful to the student than to regard every investigation, no matter how specialized, as an element in the great process that is steadily building up a general picture of the whole sweep of evolution. Beginning among the stars, this process finally leads up to the origin of man, his rise from savagery, and the dawn of civilization." Dr. Hale thus links up every field of scientific investigation and shows how all the sciences may be brought to bear on one problem, which is Breasted's method. He pays tribute to the great work which American scholars have done toward this end in bringing scientific methods into play upon the ancient civilizations in this continent and South America. The New World diffusion of culture, continuing down into our own times, is like a great laboratory experiment for the benefit of the Orientalist, showing what must have occurred about the Egypto-Babylonian group before the age of written documents."

Elements and Light Curve of SX Hydrae.— The eclipsing binary SX Hydrae, *133926*, has a photographic range of four magnitudes and apparently is not exceeded in this property by any other eclipsing star for which an accurate light curve has been determined. The position of the variable for 1900 is 13^h $39^m.0$, $-26°$ 17′. The spectral class at maximum is A3.

The variability of SX Hydrae was discovered by Miss Woods in 1912 on photographs made at Arequipa (H. C. 201). As the holder of the Whitin Fellowship of the Alumnae Association of Wellesley College, she made at that time an investigation of the period and light curve, using several hundred Harvard plates. The period then determined was 2.8957 days. A further discussion of the same and subsequent material, involving estimates on 782 plates made with seven different telescopes, gives as the corrected heliocentric elements,

$$\text{Minimum} = \text{J. D. } 2410001.2346 + 2^d.895697 \text{ E, G.M.T.}$$

The magnitude range, using the 1922 photographic standards, is from 8.6 to 12.6. The primary eclipse appears to be total. There is no indication of ellipticity or of a secondary minimum in the following tabulation, which gives, for maximum light, the mean photographic magnitude, at different phases expressed in days, and the number of observations in each mean:

Phase	—0.20	0.20	0.42	0.72	0.98	1.22	1.45	1.68	1.92	2.18	2.48
Magnitude	8.67	8.69	8.57	8.61	8.63	8.60	8.63	8.61	8.64	8.60	8.64
Observations	50	31	52	55	43	44	35	45	34	52	76

The weighted mean magnitude at maximum, excluding the two groups nearest to primary minimum and the group that covers the phase of secondary minimum, is 8.61. Including all maximum observations, the mean is 8.62.

The following sequence of comparison stars was established for the work on SX Hydrae through comparison with the standard magnitude sequence at $14^h.0$, $-23°.5$.

Designation	C.D.	R.A.1900 h m	Dec. 1900 ° ′	Magnitude	Spectrum
Var.	—26°9905	13 39.0	—26 17	..	A3
a	—26 9856	13 34.6	—27 5	7.7	K0
*b	—26 9843	13 33.2	—26 46	8.1	A3
c	—25 9945	13 35.9	—26 2	8.4	K2
d	—27 9395	13 39.3	—27 9	9.0	G0
e	—27 9386	13 38.3	—27 16	9.3	A2
f	—26 9853	13 34.4	—27 0	9.7	K0
g	—26 9918	13 40.4	—26 52	10.1	K2
h	—26 9917	13 40.3	—27 2	10.2	G0
k	—26 9895	13 38.3	—26 18	10.3	A3
l	—26 9902	13 39.0	—26 21	10.6	G5
m	—26 9901	13 38.9	—26 32	10.8	G5
n	—26 9898	13 38.5	—26 14	11.2	..
o	—26 9903	13 39.0	—26 20	11.5	..
p	—25 9970	13 39.2	—26 7	11.7	..
q	—26 9913	13 40.1	—26 37	11.7	..
r	—26 9889	13 37.8	—26 30	12.1	..
s	.. ..	13 38.3	—26 27	12.4	..
t	.. ..	13 38.7	—26 23	12.7	..
u	.. ..	13 39.3	—26 8	13.0	..
w	.. ..	13 38.9	—26 26	13.4	..
x	.. ..	13 38.7	—26 12	13.7	..

*b is suspected of variation.

The orbit of SX Hydrae is being computed at the Harvard Observatory. The observations during primary minimum will be given when the orbital elements are published. The individual observations of maximum light will be kept on file unpublished.

Harvard College Observatory Bulletin 791.

Concerning the Star B.D. +35° 4505.—In a communication published in *The Observatory* for June, Rev. Thomas D. Anderson, of Inneswick, Scotland, suggests that the object reported by him as a nova on May 8, 1923, may possibly be the ninth magnitude star B.D. +35°4505. Numerous photographs made here during October, November, and December, 1922, and in March and May, 1923, show the star at constant brightness.

In order to see if the star has behaved abnormally in the past, a part of the Harvard photographs of the region have been examined. By selecting plates from the series A, I, AC, AX, and AI, it was possible to cover every year from 1890 to 1923. No certain variation in the star's light is found on seven hundred plates. None of the other faint stars near the suspected object appear definitely to show variability.

The spectrum of B.D. +35°4505 is very near Class A0.

Harvard College Observatory Bulletin 791.

Dr. Arthur Rambaut, in charge of the Radcliffe Observatory of Oxford University, died in October. Dr. Rambaut had been in poor health for many years.

Gyroscopic Motion.—The mathematicians say that the "classical" or "accepted" theory of gyroscopic motion holds good only under "ideal" conditions. What are these "conditions"? Friction and atmospheric resistance must be removed. But this is not all. In addition the gyroscope must be an "ideal" body—a body in which no heat will be generated by the application of the "deflective force." This force must merely change the *direction* of existing motion. It must do no more. But this is impossible in the case of a *real* body. In such case part of the "deflective force" is transformed into heat. Hence the quantity of this force will not remain constant. It will be impaired by the action it produces. And as its quantity decreases the wheel will descend. The balance between the "deflective force" and the force of gravity will not be maintained. The wheel will gradually descend to lower levels until the axle hangs upright. So with the earth. The earth is a *real* not an "ideal" body. Hence the "deflective force" will grow weaker and weaker and as it weakens the poles will spiral around until the axis stands perpendicular to the orbital plane. To this pass the planets Mercury and Venus and a number of satellites have already come.

L. A. REDMAN.

San Francisco, October 17, 1923.

The Book of the Stars for Young People.—This new book by William Tyler Olcott is just the book for parents who wish to interest their children in the study of the constellations, or for the leaders of the Boy Scouts in connection with the same study. The book contains about 400 pages and is written in very simple language. Diagrams are given showing the constellations visible at 9 P. M. in different seasons of the year, and also showing each separate constellation with the imaginative figure which gave the name to the constellation. With the description of each group the more interesting myths and legends associated with that constellation are given.

We notice that as the book was printed the page heading given was "Children's Star Book." It is, however, not simply a children's book, but people of all ages will find it very interesting, especially those who are beginning the study of the stars.

The book is published by G. P. Putnam's Sons, New York and London.

THE STAR SIRIUS.

A diamond in sky at night,
Alone, afar:
Or bluish beacon, beaming bright,—
Canicula.

When winter wakes and world is white,
Then shines that star;
Supernal and sublimest sight,—
Canicula!

—CHARLES NEVERS HOLMES.

41 Arlington St., Newton, Mass.